CIVIL ENGINEERING

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THE SOUTH CATAMOUNT CREEK DAM, NEAR COLORADO SPRINGS, COLO., TYPIFIES THE USE OF STEEL FACINGS FOR EARTH AND ROCK-FILL STRUCTURES. THIS TYPE OF DESIGN IS DISCUSSED ON PAGE 7 OF THIS ISSUE

Volume 9 — *Number 1*

JANUARY 1939

New York World's Fair

Air View Looking North to Flushing Bay. The New York World's Fair Grounds Are the Objective of One of the Society's Saturday Inspection Trips During the Annual Meeting Jan. 18-21.

Among Our Writers

Charles M. Upham (Tufts College and University of North Carolina) has held many important posts in the field of highway engineering, among them chief engineer, Delaware State Highway Commission; chief engineer, North Carolina State Highway Commission; and secretary, American Association of State Highway Officials.

Holton D. Robinson graduated from St. Lawrence University in 1886 and has been actively engaged in the design and construction of large bridges for 52 years. A list of his engagements as designer or consultant would include most of the large suspension bridges built in this country and abroad in the past half century.

R. T. Logeman (University of Wisconsin, 1899) has been with the American Bridge Co. since 1908. Earlier experience included 9 years of railroad work in the Middle West. He is a member of the Western Society of Engineers.

Raymond A. Hill has long been active in Society affairs. He served as president, Los Angeles Section, in 1926, and is now completing his three-year term as Director of the Society. A member of the firm of Quinton, Code and Hill–Leeds and Barnard, his engineering practice is largely in connection with hydraulic works, particularly irrigation and water supply.

P. B. Streander has had 26 years of sanitary engineering experience. Since 1934 he has been with George L. Watson in New York City. Earlier connections were with the Sanitation Corporation, the Roberts Filter Manufacturing Co., and consulting engineers in Pennsylvania and New Jersey. For several years he was also in private practice in Philadelphia.

H. S. Riesbol (University of Idaho, 1929) joined the U. S. Bureau of Agricultural Engineering in 1930, after one year with the Chicago Bridge and Iron Works. His first work with the Bureau was on soil erosion studies. His present assignment dates from 1935.

H. G. Gerdes (University of California, 1922) spent 10 years in California on hydraulic investigations, and in 1932 went to the Portland (Ore.) office of the U. S. Engineer Department, where he was in charge of Bonneville Dam design. From 1935 until July 1938 he was with the Federal Power Commission on cost investigations of water power projects.

E. A. Jacob, twice city engineer of Provo, Utah (1907–1912 and 1932 to date), has also served as irrigation engineer of several Utah companies. Since 1934 he has been engineer and secretary of the Provo River Water Users Association (Deer Creek Project).

E. O. Larson has an enviable record of service with the U. S. Bureau of Reclamation. For many years he has been a student of water resources problems in the mountain states.

Elwin G. Speyer's experience includes service as special consultant to the N. Y. State Port Authority Survey Commission, as consultant to the Buffalo Police Department on traffic regulation (1930–1934), and as special consultant to the N. Y. State Legislative Committee on Traffic Regulation.

S. M. Bailey (University of Cincinnati, 1920) spent 10 years in municipal and sanitary engineering in Kentucky and North Carolina. Since 1930 he has been employed on flood control work, both design and construction, in various offices of the U. S. Engineer Department.

G. R. Schneider (University of Wisconsin, 1922) was engaged until 1934 in design and construction of dams, hydro plants, and highways. Since then he has been with the U. S. Engineer Department on flood control work—at present as head of the Design Section, Little Rock District.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Diversion—the Highway Handicap

Sacrificing Safety and Utility in the Name of Expediency

By Charles M. Upham
Member American Society of Civil Engineers
Engineer-Director, American Road Builders' Association, Washington, D.C.

FORTY years ago the automotive industry was in its infancy. The horse and buggy was still the chief mode of transportation and the average speed of the horse-drawn vehicle was greater, in most cases, than that of the motor car of that day. The automobiles of forty years ago were few, clumsy, and slow-moving.

What a difference the 1938 highway presents! Streamlined, high-powered cars, trucks, and trailers crowd all the main arteries. Their speed has increased from 10 or 15 miles to 50 or more miles per hour. The motor vehicle of today is a triumph of scientific engineering skill. But, while these changes have been taking place in the vehicles that use our highways, the highways themselves have, in too many cases, remained in their pre-war state. Thirty million cars are expected to occupy the road space which was constructed for a fraction of that number. The building of highways has failed dismally to keep pace with the output of automobiles.

To Cut Accidents in Half.~There are in the United States today approximately 3,300,000 miles of roadway over which motor vehicles may travel. This mileage includes city and village streets, paved and unpaved country roads. While nearly one-third have some form of improvement, only about 180,000 miles are paved.

One result of this failure of our roads to meet the demands of modern traffic is a steadily increasing death toll in highway accidents. Thirty-seven thousand eight hundred people were killed in automobile accidents during 1936. The number of fatalities in 1937 increased to 40,000 and, while there is some reduction in this year's fatalities, the prospects for the future are dark indeed unless action is taken to bring our highways up to date.

The insufficiency of our present highway system can hardly be blamed on the profession. Our road-building engineers have perfected complete plans that will make our highways safe for the requirements of modern traffic. Weaknesses in our roads, which are partially responsible for the majority of our accidents, include narrowness, bottleneck bridges, sharp curves, railroad grade crossings, highway intersections, slippery surfaces, narrow and soft shoulders, unguarded precipices lack of provision for pedestrians and, in special cases, insufficient illumination for night driving.

To correct these weaknesses, our engineers propose the construction of four-lane highways with center parkways to separate opposing streams of traffic; the installation of lighting fixtures on the most heavily traveled roads; the skidproofing of all surfaces; the leveling of grades and the banking of sharp curves; the provision of walkways for pedestrians; the elimination of all grade crossings and blind intersections and the provision of guard-rail protection where needed. It has been estimated that highway accidents could be reduced at least fifty per cent if this program were put into effect.

Funds Already Available.~To carry out the plans of these engineers would, of course, require money, but it would not require the levying of a single additional tax on highway users. For the American motorist is at present paying to the government huge sums for the construction and maintenance of safe roads. On every gallon of gasoline that he buys, he pays both a federal and a state tax. Each year, also, he must buy a new license for his car. Throughout the year the average motorist will pay, in addition, at least one fine for a traffic violation. All this money is his contribution to the upkeep of the highways. If used for this purpose it would be more than sufficient for our highway needs. However, this is not the case, for a large proportion of the money collected from highway users is being diverted to purposes totally unrelated to highways.

Just as the highway fatality rate has been increasing year by year, so has the misappropriation of highway revenues. In 1937 more than $161,413,000 of our highway money was diverted to other uses, with a disastrous effect on the plans of the highway engineers in many states. Today, approximately 25 cents of the motorists' tax dollar is spent for projects that have nothing to do with highways. In addition, 22 states have a general sales tax which levies a further burden upon the motorist. Furthermore, over two-thirds of the states apportion highway funds in varying amounts to local units of government with the provision that they be spent for highway purposes. In general, this money is spent in accordance with this provision, but there are enough exceptions to total nearly $40,000,000 for the country as a whole.

Government Attempts to Help.—The Congress of the United States expressed its disapproval of the practice of diversion in no uncertain terms when it passed the Hayden-Cartwright Road Act of 1934. This act declared that "it is unfair and unjust to tax motor-vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement, or maintenance of highways". The federal government, however, has also been guilty of this practice of diversion. It has already collected from the highway users $194,000,000 more than it has expended for federal-aid highway improvements. With the continuance of federal aid on the present basis, the federal treasury will continue to show a profit of upwards of $150,000,000 annually from the diversion of motorists' taxes.

Congress has gone farther than mere words in its condemnation of diversion by state legislatures. The Hayden-Cartwright Act provides that federal-aid funds shall be withheld from those states that divert their own highway money. This provision has already been invoked against two states, with New Jersey suffering a reduction of $250,000 and Massachusetts losing $475,000 of federal-aid highway funds because of their diversion activity. Two other states are at present being examined in order to determine whether they shall be penalized for this practice.

States Also Are Alert.—Gradually the public is becoming aware of the harm that is being done by diversion. On last election day, November 8, New Hampshire, California, and Michigan returned tremendous majorities in favor of constitutional amendments against diversion. At the present time, therefore, 7 of the 48 states have inserted anti-diversion provisions in their constitutions, since Colorado, Kansas, Minnesota, and Missouri had already adopted similar amendments. Anti-diversion amendments have been approved once by the legislatures of Indiana and Nevada and, if approved again by the 1939 legislature, will be submitted to the people for their approval. The legislatures of all the states, with the exception of Kentucky, Louisiana, Mississippi, and Virginia, will meet in 1939, giving highway users and other road-minded groups the opportunity to bring anti-diversion proposals before them and again unite to permanently end this practice.

It has been argued that the purposes to which highway money is diverted are also necessary and important. That may be true. If our country's highway system were adequate and safe for all the traffic which must use it, we of the highway profession and industry would not protest a reduction in the amount of money appropriated for roads. But this is patently not the case. Until the safety features recommended by highway engineers are incorporated in the majority of our highways, we cannot afford to spare a single highway dollar for use elsewhere, no matter how worthy the cause.

The principle upon which diversion is founded is economically most unsound. A state might succeed in balancing its budget by robbing the highway fund, but the cost to every citizen of that state would be tremendous. The loss in dollars and cents which results from failure to provide good and safe roads is far greater than the cost of such roads. There is, first of all, the money which must be spent in hospitalization, repairs for automobiles, and damage suits as a result of automobile accidents. There is the loss of valuable time to the busy man who must travel over a poor road. Worst of all is the deplorable loss in human lives.

Who Stands the Loss?—The farmer is one of the chief sufferers from diversion. The secondary roads of this country are in a lamentable condition. Of the 30,000,000 farm people in the United States, 60 per cent live on unimproved dirt roads which are oftentimes made completely impassable by rain. For the farmer, the result is serious social, cultural, and economic loss. He is delayed in getting his perishable produce to market and his farm equipment suffers great wear and tear when driven continuously over these rough roads. His children are deprived of educational advantages when they cannot get to school during months of rainy and stormy weather. The social activities of the farmer and his family are sharply curtailed by the bad roads which often mean that he has no contact with his neighbors for weeks at a time. Accident, sudden illness, fire—in fact any emergency on a farm—may mean the loss of life or valuable property before aid can be reached over a road filled with mud holes.

Others beside the farmer are hurt by diversion. The task of the rural letter carrier is made doubly difficult by the necessity of crossing rough, muddy roads to deliver the mail. The territory which the country doctor is able to cover depends largely on the condition of the roads in his community. Every other rural business and professional man finds his income dependent, to a great extent, on the condition of the roads.

The tourist trade is rapidly becoming America's largest industry. Cities and states vie with each other to win the attention of the traveling public and to persuade tourists to spend vacation time and money within their borders. The merchants in the communities which are avoided by tourists because of bad roads suffer serious loss of revenue which would otherwise be theirs. The tourists also must be considered in discussing those affected by road conditions. Although travel by motor is not an economic necessity for them, it nevertheless forms an important part of their personal life. Bad roads mean a decrease in their pleasure and comfort and a proportionate increase in their expenses and hazards. Every man, woman, and child who drives or rides over America's roads for business or for pleasure must be included in the number of those who are injured by the diversion of highway funds.

It is, therefore, no exaggeration to say that every American, whether he lives in city, town, or country, has a very personal interest in the American highway system. The motor-vehicle taxes that he pays represent his investment in good and safe roads. On the proper use of this investment may depend his life and the lives of his loved ones.

The diversion of highway money to non-highway purposes drastically retards the construction and maintenance of up-to-date highways. The state that tolerates this unsound practice brings down upon its head immeasurable detriment. Men, women, and children who live within the borders of a state that misuses its highway money eventually suffer loss of time, money, property, and, all too often, the dearest possession of all—life.

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NUMBER 1

Building the Deer Isle–Sedgwick Bridge

Work on 1,080-Ft Suspension Span in Maine Involves Many Unusual Features

By HOLTON D. ROBINSON

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ORIGINALITY is reflected in the construction methods adopted for both the substructure and the superstructure of the Deer Isle–Sedgwick Bridge, which is now nearing completion. In the accompanying article, Dr. Robinson not only describes these methods but takes pains to emphasize the factors that led to their selection. Reading between the lines, one may also note the important influence of these methods on various details of the design itself.

THE Deer Isle–Sedgwick Bridge, in Hancock County, Maine, gained its name from the two townships which it physically connects by spanning Eggemoggin Reach, an arm of the sea separating Deer Isle from the mainland. Island residents in the past have depended upon a flat-boat or scow ferry towed by a motor-boat—and before the advent of gasoline motors perhaps operated by steam-engine or horse-driven tread mills. This service was slow, discontinued in times of storm and ice, and always very expensive. The Deer Isle–Sedgwick Bridge will furnish a quick and modern means of highway transportation for the island residents, and at the same time remove a barrier which has kept many residents of the state and vacationists from visiting the famous granite quarries and enjoying the natural scenic beauty of Deer Isle.

The engineers' problem was to construct a modern long-span high-level bridge with rather deep foundations, across an exposed arm or reach of the Atlantic Ocean, at the lowest possible cost commensurate with safety and durability. Their solution was a suspension-type structure with a main span of 1,080 ft, two equal side spans of 484 ft each, and six 65-ft continuous deck-girder approach spans.

GENERAL DESCRIPTION OF BRIDGE

The two main cables of the suspension bridge are each composed of nineteen $1^1/_2$-in. diameter galvanized steel bridge strands. Each suspender is composed of two parts of $1^1/_8$-in. diameter, 7-strand, galvanized steel bridge cable. These suspenders, like the main cable strands, are pre-stressed, measured to accurate predetermined length when under structure dead-load stress, and socketed to that length so that no field adjustments—in former times always a headache maker—are necessary. The small adjustments required on the main cable strands were easily made by turning the sleeve nut connecting each strand socket to its respective anchorage rod. This type of connection was invented by the author and first used in the construction of the Thousand Islands Bridge, as described in an article by D. B. Steinman, M. Am. Soc. C.E., in the June 1938 issue of CIVIL ENGINEERING.

The structure provides a 20-ft concrete roadway with two 15-in. emergency walks, and is stiffened with $6^1/_2$-ft-deep plate girders. It was designed for H-15 loading and in accordance with the American Association of State Highway Officials specifications, with the necessary modifications for long-span structures.

Eggemoggin Reach is navigable at the bridge site and in fact is one of the most popular sections of the Maine coast for yachting. The War Department required that an underclearance of 85 ft above mean high water be provided for a channel width of 200 ft at the middle of the main span. This requirement brings the roadway grade at the center of the main span to an elevation of 98.7 ft above mean sea level. By adopting steep approach grades of $6^1/_2$ per cent and a comparatively short vertical curve of 400 ft at the center of the main span, the approach viaducts were kept to a minimum length.

Each tower column or leg is composed of two 36-in. wide-flanged beams, spaced 5 ft on centers, with flanges connected by heavy batten plates and double angle lacing. The two legs of each tower are braced together with double-web horizontal girder struts, 7 ft high, spaced about 35 ft on centers. The plate webs of these struts are perforated for architectural appearance, and two narrow vertical members, extending between struts from above the roadway portal to the top of the tower, divide the tower into more harmonious proportions and give

DEER ISLE-SEDGWICK BRIDGE, MID-DECEMBER 1938
Most of the Suspender Ropes Have Been Placed. Note Temporary Gallows Frames on Top of Main Tower and Cable Bent, and Cage near Cable Bent

some added rigidity. Below the roadway, similar struts and diagonal bracing are used to transfer wind shear to the main pier top.

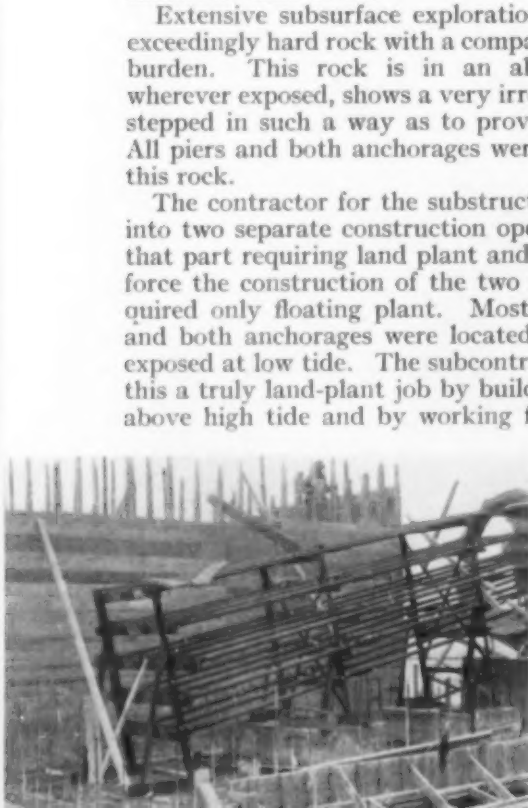
The bottom sections of the tower, to a height of 78 ft above the top of the pier, were erected by derrick boat. Then a so-called "creeper" traveler, made up of the main girders of approach spans, braced together, was attached to the rear face of the horizontal struts at the center line of the tower, for use in placing the remaining sections. To the top of this traveler, about $2^1/_2$ tower bays in height, was attached a horizontal girder framing or "hammer-head," which projected far enough in front of the tower to permit operation of the hoisting tackle. The tower sections were assembled one at a time, by the derrick boat, on a braced timber frame cantilevered out from the front of the tower at roadway level.

SEDGWICK MAIN TOWER
Creeper Traveler, in Its Highest Position, Has Just Set Top Tower Section

During three days' presence on the work, the writer saw a section of tower assembled each day, the "creeper" jumped to its new position for hoisting, and the newly assembled section (weighing 35 tons or more) placed, the Sedgwick tower being finally topped out on the third day. It almost seemed as though the traveler should be called a "jumping" traveler, as the time required either to hoist the traveler itself to a higher position or to lift a tower section into final position, seemed almost no time at all.

Extensive subsurface explorations showed sound and exceedingly hard rock with a comparatively shallow overburden. This rock is in an altered condition and, wherever exposed, shows a very irregular surface, usually stepped in such a way as to provide ideal foundations. All piers and both anchorages were founded directly on this rock.

The contractor for the substructure divided the work into two separate construction operations by subletting that part requiring land plant and retaining for his own force the construction of the two main piers, which required only floating plant. Most of the viaduct piers and both anchorages were located on ground that was exposed at low tide. The subcontractor was able to keep this a truly land-plant job by building a material trestle above high tide and by working for the most part between tides. Some of the more shallow foundations, including the Sedgwick anchorage, were constructed inside of low sand-bag dams. The Deer Isle abutment, anchorage, and one viaduct pier, with foundations at about El. -13, were all enclosed in one double-wall timber cofferdam with puddled core. The overburden of stiff blue clay was found so firm within this cofferdam that Pier 2 was excavated to rock at El. -19 without using a dam. The walls of this excavation stood practically vertical even though the pit was flooded at each flood tide. As each tide receded, the pit was pumped out and excavation continued in the dry until completion. The only floating equipment required by the subcontractor was a barge for ferrying material and equipment from the mainland to Little Deer Isle.



ANCHORAGE RODS BEFORE POURING OF CONCRETE

Design and construction of the main piers was more difficult than the average because of the depth to rock, the shallowness of the overburden, the 10.2-ft mean tidal range, and the exposure to severe coastal storms. Rock at the north main pier was inclined toward the center of the waterway on a general slope of 1 on $2^6/_{10}$ and at an average depth of 72 ft below mean sea level, and was covered with about 12 ft of overburden. Rock at the south main pier was similarly inclined toward the center of the waterway on a general slope of 1 on $1^9/_{10}$ and at an average depth of 54 ft below mean sea level, covered with about 2 ft of overburden. The overburden was soft on top but very compact hardpan near the rock.

Each of the two main piers includes a rectangular base, 28 by $60^1/_2$ ft in plan, and about 29 ft in average thickness. This base extends up to El. -25 for the south pier and El. -43 for the north pier. On top of this base, and connected to it only by the bond between the two pours of concrete, rests a 10-ft-thick reinforced slab of dumbbell shape. This in turn serves as a pedestal base for twin cylinders, 14 ft in diameter, which extend 25 ft above mean sea level and are braced together at the top with an arched portal.

A NOVEL METHOD OF PIER CONSTRUCTION

The original design for these piers contemplated the use of an open steel sheet-pile cofferdam, which was to be sealed with a tremie pour and then unwatered so that the substructure work could be completed in the dry. Alternate designs on the bidding plans suggested and permitted other methods. After the contract was awarded, the contractor, Merritt-Chapman and Scott Corporation, developed one of these alternate suggestions, with some modifications, into a method for construction which was novel and successful. This method consisted essentially of the following operations:

1. Prefabrication of the steel sheet-pile cofferdams and their steel framing in the contractor's Staten Island yard, the dams being of a height equal only to that of the specified rectangular base.
2. Similar prefabrication of a metal form, with structural members for reinforcement, for the 10-ft-high dumbbell shaped pedestal.
3. Similar prefabrication of metal forms for the twin cylinders, by using $^1/_2$-in. steel plates below the specified wrought-iron plates. This form was made in two sections, the lower one to extend 2 ft into the 10-ft pedestal and 3 ft above it, where the splice could be made with flanged connections. (Between El. -8 and El. $+8$, wrought-iron plates were used; these were designed to be left in place to protect the masonry from the effect of salt water and ice abrasion within the tidal range.)
4. Assembly of prefabricated dams on barges at the site.
5. Dredging and jetting the overburden from the site.
6. Taking soundings to determine the configuration of the cleaned rock foundation.

7. Burning off bottom of assembled dams to fit rock profile.

8. Placing the completely assembled dams, weighing about 135 tons each, with derrick boat; leveling up with four adjustable spuds; and filling with tremie-placed concrete.

9. Placing steel forms for 10-ft slab with 5-ft section of cylinder forms, and filling with tremie-placed concrete.

10. Placing remainder of cylinder forms, unwatering, and completing in the dry.

This method of constructing the piers was successful and is believed to have been the most economical method for this particular work under the existing and specified conditions. The contract, executed on December 3, 1937, called for completion of one main pier on June 1, 1938, and the second on August 1, 1938, with substantial liquidated damages for failure to complete the work on time. These specified completion dates and the magnitude of the work involved made it essential that the work be started during the winter months, but the rigors of the Maine winter, high tides, and severe exposure to coastal storms would have made an early start in the field very hazardous and expensive. The method adopted permitted large-scale prefabrication during the winter in New York, and field assembly in a cove near the site during the early spring. It also permitted excavation at the site in early spring without the necessity of dredging through small pockets in the dam framing, and without the hazard of constructing and maintaining a large cofferdam in deep water during March gales. The top of the cofferdam as constructed was sufficiently far below the water surface to be practically free from the effects of tides and storms. When the cylinders—the first form work to appear above the surface—were erected, they were anchored to the previously constructed base and hence were very secure against storm damage. In fact each form as set could be concreted almost immediately, thus reducing the hazards still more.

Going Down!
Availability of Heavy Floating Equipment Made This Method of Cofferdam Placing Feasible

Under the originally proposed method of construction, the depth of seal concrete on the deepest pier was theoretically sufficient to prevent flotation under favorable conditions, considering the weight of steel cofferdam framing, and making some allowance for side friction of the overburden. But reasonable precaution by the contractor to prevent flotation during exceptionally high tides or severe storms would have probably required weighting of the dam or an increase in the amount of seal concrete. The method adopted by the contractor removed all the hazards of flotation, and this feature alone is considered of prime importance in any comparison of methods. It is quite possible that the adopted method would permit a substantial reduction in the depth of seal concrete on similar projects.

Steel Sheet-Pile Cofferdam for One of Main Piers, with Bottom Edge Burned Off to Fit Rock Profile

Another governing factor in the choice of method was the availability of the contractor's own large fleet of heavy floating equipment. The placing of completely assembled dams with their bracing, of the size required on this project, would probably be impracticable or uneconomical without the use of a heavy derrick boat obtainable at a reasonable rental charge. Adjustment of the construction schedule to permit placing the two large dams in immediate sequence effected another saving as it required only one tow of the heavy derrick boat to the site, thus reducing its rental period.

The contractor had on hand suitable second-hand steel sheeting of the required length for the design adopted, and suitable second-hand structural shapes for the cofferdam bracing. Use of low-scrap-value material already on hand, plus shop fabrication, versus the purchase of new timber and steel with field fabrication at inadequate waterfront plant, was an added economic feature in favor of the adopted design.

It does not follow that the selected method of construction would be cheaper for all piers under similar physical conditions; on the contrary this project emphasizes the need of studying each construction project in detail, making allowances for all general and special conditions, and then selecting a method, old or new, which the study indicates will prove the most economical.

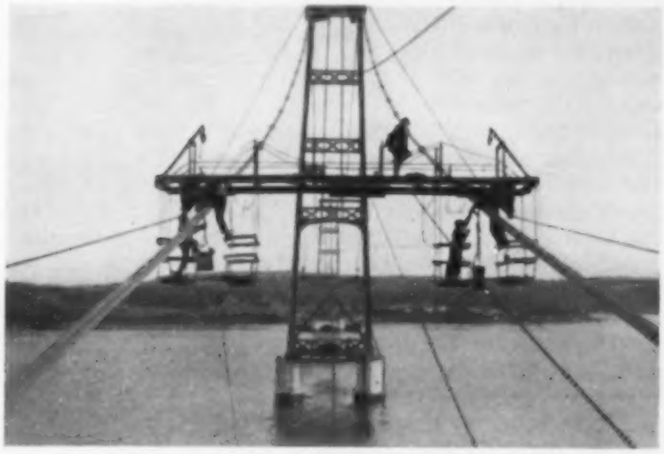
Soundings were taken over the pier bottoms with a novel "plumb bob," or sounding rod, consisting of an 80-ft latticed steel derrick boom fitted with a large-diameter steel point and weighing, all told, about 8 tons. It was suspended from the boom of a floating derrick and soundings were taken on 1-ft centers around the cofferdam perimeter for determining the contour of the dams, and on 5-ft centers for determining the general configuration of the rock foundations. While the soundings and diver reports indicated that the bedrock was very irregular and naturally benched to form an adequate foundation, steel dowels were installed as an additional factor of safety. These dowels, 2 in. in diameter and 4 ft long, were placed where the slope exceeded 1 on $1^3/_4$, and were spaced to furnish one dowel for every 8 sq ft of such sloping surface. This required the installation of 30 dowels in the north main pier foundation and 75 in the south pier. The dowels were placed to project 2 ft into the rock and were grouted in place with neat cement.

ERECTION OF CABLE STRANDS

The viaduct superstructure was erected at high tide with a derrick boat. Erection of the cable strands followed conventional methods with minor variations. A cage or transverse platform, spanning from cable to cable, and supported on independent cage ropes above the main cable, was used in each span in place of the more common foot-bridges or catwalks. Such cages are somewhat cheaper than foot-bridges and furnish sufficient provision for workmen and inspectors when pre-stressed strands are used with locations for cable bands predetermined and marked on one master strand for each cable.

In the past the haulage ropes for pulling the individual strands across the waterway have been located at or

near each main cable. On this project the contractor used a haulage rope located on the longitudinal center line of the bridge (Fig. 1). After each strand was hauled across the spans and made fast at its anchorage connec-



PLACING CABLE BANDS IN DEER ISLAND SIDE SPAN
Cage Is Supported on the Ropes at Extreme Right and Left. Cable Bands Were Raised to Position by Tackle Operated by Gasoline Hoist from Deck of a Small Scow

tions, its bight was picked out of the supporting sheave at the center of the top of each main tower, by means of two sets of small wire-rope tackle and blocks suspended from a gallows frame, and then quickly fleeted to position in the tower saddles. The strands were readily laid in their places in the cable bent saddles at the shore end of the side spans on account of the very slight bend of the unloaded strands at that point. This method of cable-strand erection is best adapted to narrow bridges where the required transverse fleeting at the main towers is a comparatively short distance.

Placing of the main-cable panel-point bands and suspenders has been completed, and erection of the stiffening girders and floor system has just begun. The contractor plans to do this work with the derrick boat used in the erection of main towers and viaduct spans. The steel will be picked off the supplying deck scow by the derrick boat and raised to position, where the stiffening girders will be pin-connected to the sockets of the suspender ropes. Erection of stiffening spans by means of derrick boat has been quite infrequent in the past, but is well adapted to an all-water job where the structure has a comparatively small underclearance above water level.

The main tower cable saddles, which were set shoreward of final position 15 in. during the erection of the cable strands, will be returned to their true position by jacking in three 5-in stages. The first stage was accomplished after all strands were adjusted in place and certain of the cast-steel panel-point suspender bands were temporarily bolted in place around the cables at each end of the tower saddles to prevent any possible slipping of the cable strands in the saddles. The second stage of the saddle jacking will follow the erection of certain main-span sections of the stiffening girders, and the final jacking to correct position will follow the hanging of certain other sections of main-span girders. Thereafter erection in the main span will continue until the middle half of the span is completed. Then will follow the erection of about half of each side span, beginning at the cable bent or shore end of these spans. After that the main span will be completed, and finally, the side spans. This method of piecemeal erection in the three spans is pursued to avoid any undue stressing of the towers or masonry connections.

The modern trend in bridge designing is to use light-weight floors, and in the case of suspension bridges, to use more and more shallow stiffening trusses or to use stiffening girders in place of trusses for even long-span bridges. Recent experience has shown that light bridges of this type with shallow stiffening members, particularly when on steep grades where intermittent or gusty quartering winds can strike the under side of the floor, have a tendency in the main span to undulations similar to wave movements, yet are perfectly satisfactory under heavy live load alone. This movement upward at one quarter point and in the opposite direction at the other quarter point, with reversals also in the side spans, can

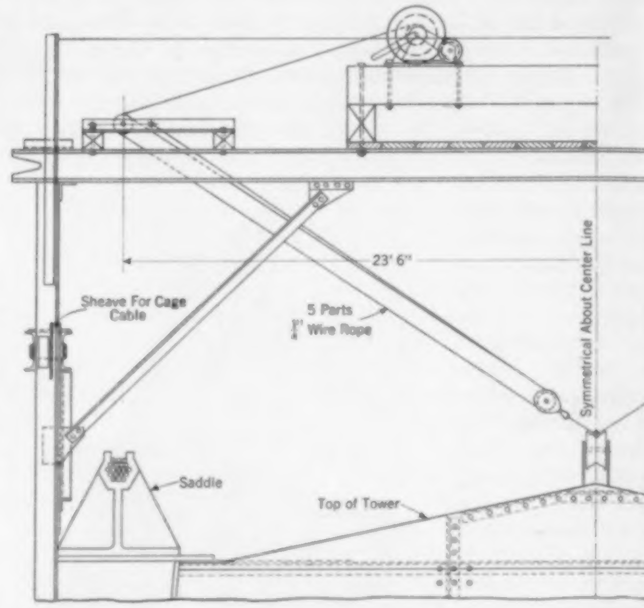


FIG. 1. PROVISIONS FOR FLEETING CABLES INTO MAIN TOWER SADDLES

be unpleasant for timid passengers even though it does not indicate any lack of strength or safety in the structure. It can be practically eliminated by bracing the stiffening girder to the cable at the middle of the main span to prevent its relative longitudinal movement, and by installing diagonal stays from the ends of the stiffening girders to a few points on the main-span cables near each tower. This additional stiffening of the Deer Island–Sedgwick structure has been authorized at an additional cost of slightly less than $5,000.

The bridge is being built as a PWA project and is expected to be opened to traffic in June 1939. Its total cost will be about $970,000.

ACKNOWLEDGMENTS

The structure was designed and its construction is being supervised by Robinson and Steinman, consulting engineers, New York, N.Y., with R. M. Boynton in charge of design and D. G. Letourneau, Assoc. M. Am. Soc. C.E., as resident engineer at the site. For Merritt-Chapman and Scott Corporation, who hold the substructure contract, Frank W. Barnes, M. Am. Soc. C.E., is construction manager; R. E. De Simone, New England district manager; and William Denny, superintendent. For the Phoenix Bridge Company, contractors for the superstructure, J. R. Lambert, M. Am. Soc. C.E., is chief engineer; J. F. Kinter, superintendent of erection; and H. A. Archinal, superintendent.

Steel Facing for Dams

Economies in Gravel and Rock Fill Structures Made Possible by Use of Membrane of Bolted and Welded Design

By R. T. LOGEMAN
ENGINEER, AMERICAN BRIDGE COMPANY, CHICAGO, ILL.

USE of steel for the impervious membrane on the water face of gravel and rock fill dams dates from about the turn of the century. However, from 1907 until early in the present decade, steel as a material for fixed dams went into eclipse. The recent revival in its use merits serious attention. Economy, safety, and ease of maintenance all favor the steel facing, says Mr. Logeman, who bases his statements on practical experience with five installations of this type. This paper was submitted for the recent competition of The James F. Lincoln Arc Welding Foundation, of Cleveland, Ohio, in which it received an Honorable Mention award in the Miscellaneous Structures Division of the Structural Classification.

DURING the past few years construction of a number of gravel and rock fill dams with steel facings has reopened a field for the use of steel that has been dormant for a quarter of a century. This type of construction represents an assembly and application of materials, based on correct engineering design, that offers something both new and economical in dam work. Three prime materials are involved, each placed where most efficient: (1) the fill to take the water pressure, (2) the steel face to form the watertight seal, and (3) the concrete in the foundations and cut-off walls to carry the water seal to bedrock or other impervious material.

Steel makes an ideal material for dam work. It has strength, is elastic to respond to temperature changes and settlement of the fill, and is 100 per cent impervious. No other material can equal it in these very important features. Other materials may lay some claim to imperviousness, but lack the necessary strength and elasticity to maintain a watertight surface in case the fill settles.

Steel has been and is being used extensively in the movable parts of dams, but has not been in common use for fixed dams. According to the records, the first such use in this country was in 1898, when an all-steel dam of the "Bainbridge" type was built for the Santa Fe Railway at Ash Fork, Ariz. It consists of steel bents about 8 ft apart, with the inclined sides, facing upstream, having a slope of 45 deg, to which cylindrically-curved plates are riveted, concave to the water. This dam is 46 ft high and 184 ft long, and is still in service, in good condition, with practically no depreciation since its construction. The only maintenance has been a coat of paint at intervals of about seven years.

FIRST ROCK-FILL DAM WITH STEEL FACING

About 1900, flat steel plates were used as a facing for the first time on a rock fill dam near Victor, Colo., for the Pikes Peak Power Company, now operated by the Southern Colorado Power Company. This dam is about 73 ft high and 405 ft long, 20 ft wide at the top and 148 ft wide at the bottom. The water side is quite steep, being 30 deg from the vertical. The rock fill was dumped against a dry wall of granite boulders, and the steel plates were placed about 6 in. from the wall, the intervening space being filled with a cushion of sand, gravel, and sedimentary deposit. The entire facing was riveted up with horizontal butt straps and calked in the same manner as in boiler practice. The plates were punched at the site, are 1/2 in. thick at the bottom, reduced to 3/8 in. about half way up, and to 1/4 in. at the top. Two 4 by 5 by 1/2 in. angles were placed vertically every 15 ft, the 5-in. legs projecting into the reservoir, with a 2 by 3/8-in. filler riveted between the extreme outer points. These angles form the expansion joints and at the same time act as stiffeners for the facing.

SWINGING STEEL PLATES INTO POSITION ON CRYSTAL CREEK DAM

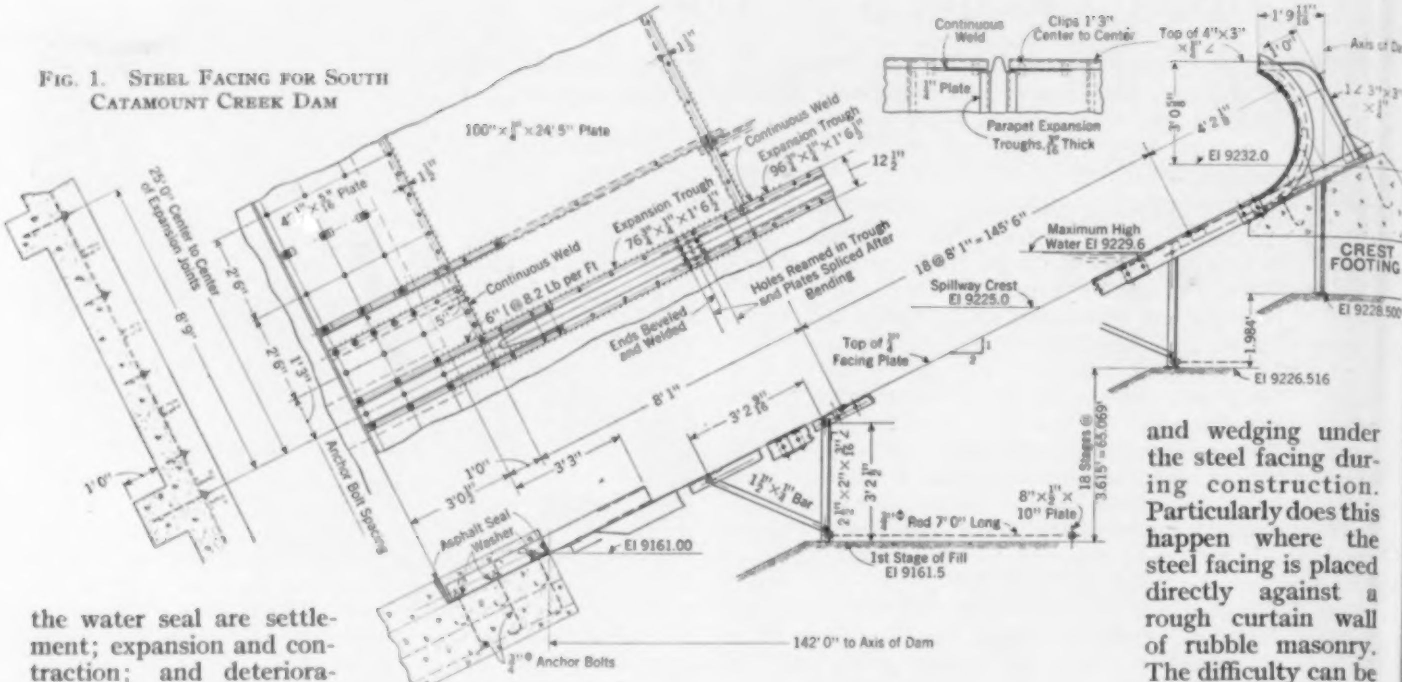
This dam has had severe service as the water has overflowed the top during flood periods and washed out some of the fill. As a result, the surface has assumed a wave-like appearance, but the plates have adjusted themselves to it without damage or need for repairs. The writer examined this dam a few years ago, when some backfilling was being done, exposing a part of the plates for about 15 ft down from the top, and showing that the steelwork was not painted on the back side but was nevertheless in excellent condition. The steel facing on the water side was covered with a bituminous paint. This dam has stood up splendidly under the severe tests it has undergone and is in condition for many more years of good service.

The second all-steel Bainbridge-type dam, 74 ft high and 464 ft long, was built in 1901 at Redridge, Mich., and also is in service today, in good condition.

The third and last all-steel Bainbridge-type dam was the Hauser Lake Dam, 81 ft high and 630 ft long, built for the Montana Power Company near Helena, Mont. When this dam was put in service in 1907 it was washed out, because the water undermined the faulty foundations that supported the steel frames. This foundation failure was used as an exhibit against the use of steel for dam construction, and however unfair, it served to stop further steel-dam installations for the ensuing 25 years. Meanwhile, however, the three steel dams in Arizona, Michigan, and Colorado served as silent evidence that steel, if not mistreated, will maintain its real and established value as a construction material.

No structure requires more care and keener engineering judgment in all features of its design than a dam. Whatever its type, the thought uppermost in the mind of the engineer is that the water must be prevented from breaking the seal—else failure of the structure may occur. In the gravity-type dam, of masonry or concrete, the structure as a whole is assumed to act as a seal against the passage of the water; in the earth-fill type, it is generally an impervious core of clay in the central part of the fill; while in the gravel and rock fill type, it is either a timber, rubble masonry, concrete, or steel facing on the water surface. The factors that have most to do with the breakdown of

FIG. 1. STEEL FACING FOR SOUTH CATAMOUNT CREEK DAM



the water seal are settlement; expansion and contraction; and deterioration.

If the impervious material is in direct contact with the water, the entire fill comes into action to resist the sliding and overturning forces, whereas if a core of clay, concrete, or steel is placed within the fill, the full resistance of the fill must be offset by the buoyancy effect of the water. With equal resistance in the fill to the water pressure, equal watertightness in the facing, and equal percolation rates, the quantity of fill can be reduced by from 25 to 50 per cent and more if the impervious facing is in contact with the water.

Of course, a central core is protected against shrinkage and temperature variations, while an exposed facing is not, and must therefore be provided with expansion joints. However, in spite of the very important advantages of protection obtainable with the central core, the logical location for the impervious material is in direct contact with the water surface, where it is accessible to inspection and repair, and where the full resistance of the fill can be utilized. Obviously, a type of facing that can and will withstand the greater variations in shrinkage and temperature is required.

Regarding the makeup and arrangement of the fill itself, there is a wide variation of opinion and practice. Advocates of the "hydraulic principle" "construct one impervious surface, and build the rest of the structure to support that surface. . . ." (George L. Dillman, in TRANSACTIONS, Vol. 75, 1912, page 52). Following this principle means careful grading of the fill from an impervious composition at the water surface to a pervious composition through the remainder of the fill. On the other hand, there are advocates of a uniform fill, with a constant density and compaction, its main purpose being to support and maintain the impervious face. Regardless of the type of the impervious face, or of the makeup of the fill, the integrity of both must be maintained under settlement, shrinkage, temperature, and deterioration.

Steel facings can either be installed after the fill is completed, or in tiers on steel horses or bents in conjunction with and just in advance of the fill. Placing the steel facing after the fill is completed, or in case of a high dam, after a considerable part of the fill is ready for the facing, will slow up the work and call for a careful finish of the fill so as to prevent loose particles from rolling down and wedging under the steel facing during construction. Particularly does this happen where the steel facing is placed directly against a rough curtain wall of rubble masonry. The difficulty can be overcome by dressing the rough masonry with a finished coat of concrete or mortar.

When the plates are laid against a rubble wall, they are anchored to it with a special type of anchor that permits them to move in all directions in response to temperature changes. On a steep slope, they are prevented from sliding down by the use of stiffeners. These are features that should not be overlooked, for unless the plates are securely anchored or stiffened, they will naturally tend to work downhill during a temperature rise.

SEQUENCE OF CONSTRUCTION OPERATIONS

For the ordinary gravel or rock fill dam, the practicable and economical method is to place the facing plates in advance, so that they can act as forms for the finished fill. Starting at the base of the cut-off wall, the first tier of plates is placed on, and connected to, the steel horses, which are spaced about 5 ft apart, and where possible the entire tier is placed and connected to both sides of the canyon cut-off walls. This insures proper assembly and fit as erection progresses. The facing plates are securely bolted to the horses, which in turn are anchored into the rolled and compacted part of the fill. The horses are also connected to the cut-off plates, which extend into the concrete and are anchored with rods extending through them and bolted to them with nuts on both sides. This precaution should be taken to prevent breaking the bond between the concrete and the steel plates, as this bond insures a better water seal.

As soon as the first stage of the rolled and compacted fill reaches the top of the first tier of plates, the second tier of plates is placed and connected to the first. The rolled fill comes within about $2^1/_2$ ft of the under surface of the plates, which is as close as the machine rollers can work, and also allows the necessary working space for erecting and painting. This space is later hand filled and tamped. In this manner tier after tier is erected and finished, and the work progresses as fast as the fill can be placed.

The size, thickness, and chemical composition of the plates are matters that depend upon the particular project—among other things on transportation facilities, quality of water, and height of dam. In general, 100 in. is

an economical width of plate, and $^1/_4$ to $^1/_2$ in. a proper thickness; and the plates extend full length and unspliced between expansion joints, which are spaced 20 to 30 ft apart.

ADVANTAGES OF WELDED CONSTRUCTION

Perhaps the most important feature of the steel facing is its assembly and welding so as to obtain both strength and watertightness. All connections and splices should be made so as to resist any moment action due either to settlement of the fill or to extreme temperature stress. This cannot be done as economically, or with the same degree of watertightness, by the old method of riveting and calking as by the more modern method of welding. It would require from three to four rows of rivets, closely spaced, on both sides of the splice, to develop the full net strength of the plate—and even assuming the rivets to be sound and tight, there would be no assurance that the calking would hold if the plates were subjected to severe bending. With present-day technique, a welded splice can be made as strong as the parent metal, at the same time maintaining the desired watertightness. This combination has decided economical advantages.

The plates are arranged for lap joints and down welding, and are punched at the shop along all four sides at about 12-in. centers, and with about a 2-in. edge distance. Punching the plates permits them to be used as they come from the rolling mills, without the necessity of the expensive edge planing that would be required for proper and safe butt welding, and also results in quick and accurate assembly in the field. Bolts are used for all the joints, the nuts being placed on the exposed surface. The bolts, with the liberal 2-in. edge distance, also act to relieve the welds from any moment stress in the lap joints, which are welded only on the exposed surface. There is no particular difficulty in welding on both sides of the joints, and there is no objection to it except the added expense. In important installations this may be justified as an added insurance for safety.

The expansion joints, which are generally U-shaped, are lap-welded to the facing plates, but for joining adjacent sections of the trough to each other a butt weld is used because it avoids the expensive taper or crimp that would be required for a lap weld. The ends are bevel planed for welding and wrapped with a splice plate that is formed to fit accurately around the expansion joint, and also acts as a backing plate for the butt welds.

The primary function of the U-shaped expansion joints is to provide for contraction, while the expansion forces produce slight ripples in the plates without the slightest injury. However, if desired, the plates can be reinforced with stiffeners so as to take compression as well as tension, in which case the expansion joints will function in both compression and tension.

All steel should be clean and protected with a carefully applied coating before it leaves the shop. Such a coating should protect it during transportation and erection, but should not prevent the making of good welds, as a painted surface would do. One or two coats of good paint are applied after the welding is completed. The plates should come in close contact and should be drawn up tight with permanent assembly bolts to insure the proper setting for welding.

When the welding is done by the electric arc process, coated rods should be used because shielding the arc produces a better, and 25 per cent stronger, weld than can be obtained with bare rods and the unshielded arc. For the lap weld, the length of the fillet leg adjacent to the plate face should be slightly increased and made to a longer slope so as to obtain a more uniform distribution of the stress. All welds are full strength and continuous, with nuts seal-welded to the plates and threads welded to the nuts, so that the finished steel surface makes an absolutely watertight cover.

Where the steel facing enters the concrete cut-off foundations along the bottom and sides of the canyon, the expansion joints should continue into the concrete so as to avoid blocking the movement due to expansion and contraction. To avoid cracks in the concrete cut-off that encloses the steel, the concrete should be thoroughly reinforced and anchored to the steel, and provided with construction joints, filled with asphalt mastic, in the same plane with the expansion joints in the steel facing. As a further precaution the finished and exposed part of the concrete cut-off can be covered with a blanket of fill which will absorb and cushion the effect of temperature changes on the concrete.

A completed steel facing conforming to the foregoing description is a continuous, watertight membrane, strong and elastic in both tension and compression. It is self-contained, and at the same time anchored to the fill itself with sufficient flexibility in the anchorage to permit adjustment to any ordinary settlement without rupture. This makes for an ideal impervious surface.

In Fig. 1 is shown the design of the steel facing for the South Catamount Creek Dam for the city of Colorado Springs, which was completed and dedicated on September 12, 1937. It embodies all the latest features in this type of construction, except that the expansion joints do not extend into the cut-off walls. Figure 2 illustrates the improved design of this detail for future installations. Reference to it shows, among other features, (1) the steel anchored to the concrete, (2) the expansion joint extending to the bottom of the steel work, and (3) the mastic seal between steel and concrete. There results, in addition to improved and safer construction, a saving of some rather expensive shop work in the fabrication of the expansion joints.

THE ECONOMICS OF WELDED STEEL FACINGS

Experience gained from our company's records, based on average conditions, shows that a riveted and calked facing would cost about $22^1/_2$ per cent more than a bolted and welded facing. The latter, in turn, must be able to establish its claim to consideration on a cost basis in comparison with any other acceptable material. However, the important matter of comparative costs should not be the one prevailing consideration in the decision as to type of structure to build. There should be also a careful weighing of such equally important factors as safety of structure, maintenance, and length of life. No general formula can be devised to cover all features, but one underlying guide for the engineer should be never to temporize with safety—because that is not economy. In comparing a steel facing with clay, timber, rubble masonry, or concrete—all of which have been and are being used—the engineer should recognize their limitations as well as their merits. All are useful building materials in dam work but should not be improperly employed.

Clay, used as the central impervious core in earth fill dams, requires an enlarged fill to maintain the core in position, and when used as an impervious blanket in rock fill dams near the water surface, it requires in addition a protecting material against wave action and scour. For low dams, where the ratio of facing costs to fill costs is greatest, the central impervious core may be economical, but for higher dams there is a very rapid increase in cost and a corresponding decrease in economy, since for a given cross-section of dam the area of facing increases

as the height, while the volume of fill increases as the square of the height.

Timber as a facing material has reasonable strength in both tension and compression, can be made reasonably

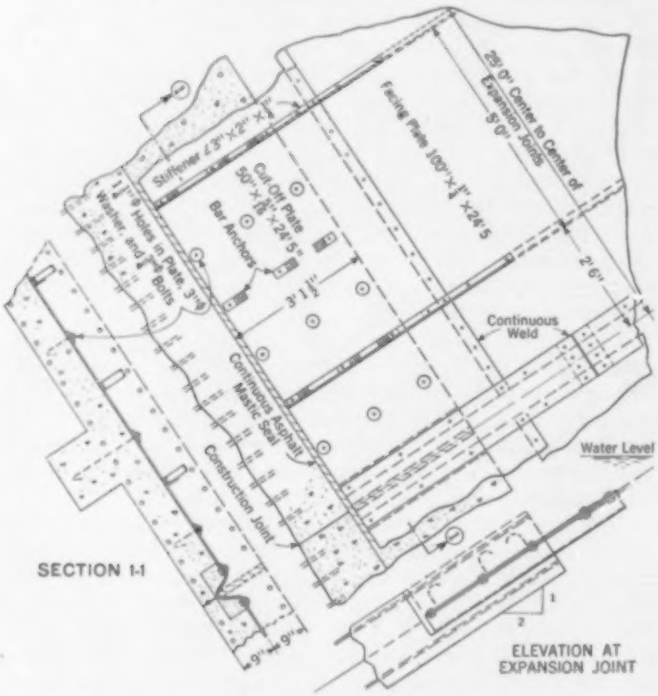


FIG. 2. CUT-OFF DETAILS FOR STEEL-FACED DAMS
Note Expansion Joint Extending Into Cut-Off Wall

watertight, is economical, especially in locations close to a timber market, and will give good service if kept constantly under water, but it is subject to rapid deterioration if alternately wet and dry. It is an excellent material for temporary dams, or for a temporary facing to be later replaced by a more permanent one after the fill has stopped settling.

Rubble masonry, carefully laid in cement mortar, can also be made reasonably tight if the water pressure is not too great, but its use is more as an intermediary, non-settling safety layer, placed between a fill that is bound to settle somewhat, and a facing of concrete or steel that should be protected against settlement.

Concrete as a facing material was first used in this country about 30 years ago. Steel and concrete have nearly equal coefficients of expansion, and therefore for all practical purposes the two materials are subject to the same dimensional changes due to temperature. In dam work, where there are large, unprotected surfaces subjected to a wide range of temperature, the movement of the facing in both contraction and expansion becomes a very important matter. Any facing built without proper provision for such movement should be made up of materials that possess sufficient strength and elasticity to absorb the temperature forces in internal stress without exceeding the margin of safety or impairing the imperviousness of the structure.

With expansion joints designed to absorb temperature stresses, the entire strength of the facing can be counted upon to resist the direct loading stresses resulting from settlement of the fill. While any extreme temperature variation should be provided for, it would be futile and irrational to attempt a design of facing that would stand up under an extreme settlement. What thickness of plate to use in a steel facing, and what thickness of slab and amount of reinforcement to use in a concrete facing, are questions that challenge the best judgment of the engineer. There is no guide except judgment and experience. Some concrete facings have been built without any reinforcement, and from all reports are giving good service, but such construction is the exception and can be justified only where there is little variation in temperature and not much settlement. The general rule has been to make the slab thickness some ratio of the height of dam—approximately 1 per cent or more of the height—and the reinforcement some ratio of the cross-sectional slab area—approximately 0.5 per cent or more.

As a supplementary aid in the final selection of the type of structure most suitable and economical for any particular installation, one might compare a steel facing with a concrete facing on a strength basis. Since the critical test on the facing as regards both temperature and settlement is one of tension rather than compression, a concrete facing as strong as the steel facing will require two sets of rods at right angles, each set of equal strength, and each set equal to the area of the steel plate.

Instead of taking a hypothetical design, let us consider an actual installation in Colorado, where the basis for such a comparison was established from competitive bidding. This installation, for which a $^1/_4$-in. copper-bearing steel facing was used, comprised about 93,000 sq ft of facing, laid on a compacted gravel fill having a slope of 2 horizontal to 1 vertical. The proposed concrete facing consisted of a slab of 10-in. average thickness, reinforced both ways, with two $^1/_2$-in. round rods, one near the top and the other near the bottom, spaced an average of $9^1/_2$ in. apart. The slab thickness was equivalent to about 1.42 per cent of the height, and the reinforcement to about 0.42 per cent of the sectional area. The strength of the concrete facing was about one-sixth that of the steel facing, while the latter showed a 3 per cent economy in cost.

No design was made and no bids were taken on a concrete slab that would compare with the steel facing in strength, and therefore an estimate is necessary to establish such a comparison. For this purpose, the same 10-in. thickness of slab and the same number and spacing of rods is taken, so that the cost of the concrete and of placing the rods remains essentially constant, and the increase in cost of the stronger slab is confined to the delivered cost of the added reinforcing material. To express the increased cost on a percentage basis, it is then merely necessary to establish the ratio of the delivered cost of the reinforcing rods to the finished cost of the concrete facing, and adjust for the 3 per cent initial difference in cost between the two types of facing.

For the concrete facing with only one-sixth the strength of the steel facing, this ratio was found to be about $12^1/_2$ per cent, while the remaining $87^1/_2$ per cent covered the constant costs of placing the bars, and the concrete.

We can now prepare the following summary, giving the increased cost of a 10-in. concrete facing over a $^1/_4$-in. steel facing:

Initial increase		3.0%
Cost based on plate area—6 × 12.5%	75.0%	
Cost based on one-sixth the plate area	12.5%	
Increased cost between respective concrete facings		62.5%
Increased cost with reference to steel facing (3% of 62.5%)		1.9%
Total increased cost		67.4%

While these comparative costs apply specifically to a $^1/_4$-in. steel facing and a 10-in. concrete facing, and are subject to change with a change in design, they are nevertheless not far from what I consider to be average conditions.

Election to Society Membership

The Mechanics of Election; Duties of Local Membership Committees, References, and Others; Typical Examples of What Does and Does Not Constitute Responsible Charge

By Raymond A. Hill

Director, American Society of Civil Engineers; Chairman, Committee on Membership Qualifications

Two-thirds of the present membership of the Society will at some time in the future request transfer to a higher grade of membership. Many other members will be referred to by these applicants and by others who apply for admission, so that the procedure of election to membership should be of interest to all members. Mr. Hill here explains this procedure in full, and a careful reading of his account should clear up many a puzzling point. More important still, it should impress each member with the care that is taken to maintain high membership standards, and with his individual responsibilities in that connection.

The procedure of election to a grade of membership in the Society is largely the function of the Board's Committee on Membership Qualifications, which is required by the By-Laws to review all applications for admission and transfer and to report thereon, with recommendations, for action by the Board of Direction.

Sources of Information

Experience has shown that the applicant may not be a competent judge of how well his own qualifications for membership match up with Society specifications. Occasionally it is found that his claims are questionable. Under instructions from the Board of Direction, therefore, the Secretary requests information and advice from many sources, for otherwise judgment would have to be rendered solely on the evidence submitted by the applicant himself. Thus only with the cooperation of the members of the Society and others whose advice is sought can action upon applications for election to a particular grade of membership be effective and consistent.

The registrar of each college or university, at which the applicant claims attendance, is asked for a statement as to his scholastic record, general standing, and character.

Each applicant is required to furnish the names of his employers, and each of these is asked for his opinion regarding the applicants professional ability and personal character and as to the degree of responsibility for the work executed by him. Reference is often made to the chief engineer of a large organization by one who was in a relatively subordinate position and about whom the reference could have little direct, personal knowledge. This results in delay. On the forms now used the name of the applicant's immediate superior is specifically requested, and information is asked of him.

The applicant himself selects and names five or more Corporate Members who are presumed to have personal knowledge of his work. Such references should be the primary source of information regarding the qualifications of applicants, but unfortunately it has been found that some members permit personal or business relationships to outweigh their duty to the Society. In many other cases, it is evident that the member referred to is not very familiar with the Constitution and By-Laws but relies instead upon impressions of their requirements.

With the hope that a request for more specific information from each reference would bring about a more accurate analysis of the true qualifications of the applicant, a new form of report was recently put in use. Objection has been made to it on the ground that the questions are too specific and that a reference should be asked only for his general opinion of the applicant's qualifications. Actually, a specific answer is asked for only as to those engagements of the applicant of which the reference has personal knowledge. Clearly, if he does not have such personal knowledge, he should make this clear, for a recommendation without personal knowledge simply tends to mislead the Board of Direction.

Occasionally information is received from some member of the Society to whom direct reference was not made, and such information is often of great value. Our membership has too generally relied in the past upon the chances that references and committees will disclose any unfavorable information. More careful scrutiny and criticism by every member, of the application lists published in Civil Engineering, is desirable.

Gradually the Board of Direction and its Committee have come to place more and more reliance upon the investigations and recommendations of the local membership committees. These are located in every principal center and in each Local Section area throughout the country, and are responsible to the Directors from their respective Districts. The Board has expressed itself as desiring that each local membership committee function as a committee—rather than leave the interviewing of applicants to but one of its members—and that so far as practicable applicants be interviewed personally.

All of the information and advice, from all of the sources available, must be taken into consideration by the Board in arriving at an equitable decision.

The Mechanics of Election

Many applications are received from men clearly qualified for the grade of membership to which they aspire, and the By-Laws provide that their names may be sent directly to letter ballot of the Board of Direction, provided that: (*a*) the applicant's statements as to his professional record are verified; (*b*) similarly as to his educational record; (*c*) no unfavorable information is received as to his ability or character; (*d*) no member of the Board of Direction or officer of the Society has requested that the application be reviewed in detail by the Committee on Membership Qualifications; (*e*) at least four (except as otherwise provided) and not less than 80 per cent of the Corporate references agree that the applicant is qualified for the grade of membership for which he has applied; (*f*) the local membership committee, to which the application was referred, recommends that the applicant be elected to the grade for which he has applied; and finally, (*g*) not less than four of the Committee on Membership Qualifications upon preliminary classification, agree that the applicant is qualified for the grade of membership for which he has applied.

About one-third of the applications fail to meet these tests of such "original clear cases," and these are then reconsidered by the Committee on Membership Qualifications, each member of which is furnished with a summary

of information and recommendations obtained from all sources, including the employers or associates of the applicant, the Corporate Members to whom he refers, and the local membership committee in the area where he is best known. Each member of the Committee then mails to the Secretary his recommendation for action, and in the event that at least four of the Committee and not less than 80 per cent of those voting are in agreement as to the grade for which the applicant is qualified, his name is sent to letter ballot of the Board of Direction, provided that the local membership committee shall have recommended election.

Cases which are not settled through this process are specially considered by the Committee on Membership Qualifications at its meetings immediately prior to the quarterly meetings of the Board of Direction. Here full discussion is had of these cases and they are disposed of in one of three ways: (*a*) the Committee, by unanimous action, if at least four of the six members are present and vote, may send an application to ballot in any grade for which the applicant is eligible; (*b*) the Committee may recommend to the Board of Direction that the application be declined, in which event the case is considered by the full Board in executive session, and action confirming or rejecting the recommendation of the Committee is taken; or (*c*) an application may be referred to the Board of Direction sitting as a committee of the whole, which in turn may send the name to ballot or may recommend rejection by the Board itself.

All these details of procedure are shown graphically in the chart on page 61 of this issue.

STANDARDS REQUIRED FOR VARIOUS MEMBERSHIP GRADES

In Article II of the Constitution the minimum requirements for each grade of membership are set forth. The basic provisions there made as to the number of years in active practice are, however, of secondary importance, except as to applicants for the grade of Junior, because substantially every applicant of the minimum age has been in active practice for a greater length of time than that specified. The minimum age for election to any particular grade is also rarely a determining factor, because few applicants have had the requisite responsible charge of work before reaching such age.

In most cases, therefore, the recommendations of the Committee on Membership Qualifications are governed by the extent to which the applicant has had responsible charge of work and the determination of what constitutes responsible charge is often a cause of confusion in the minds of applicants, references, and local membership committees. This difficulty disappears if the minimum requirements of the Constitution are read as follows:

> An Associate Member, for at least one year before his election, shall have been engaged in engineering work of substantial responsibility.
>
> A Member, for at least five years before his election, shall have been engaged in the direction of engineering work of major responsibility and shall be qualified to plan engineering work of importance.

While not official with the Board, the following examples of duties and responsibilities are indicative of standards which have been acceptable to the Board.

1. Typical examples of tasks which are frequently claimed as responsible charge but which do not fall in the category of responsible charge:

Have charge of small field party on surveys or construction, make computations, plot field notes, prepare working drawings, check final plats, and prepare data and records.

Compile data from field inspection reports, figure grades, and balance earthwork; check vouchers against original estimates; run center lines and levels, stake out construction work; inspect grading and concrete work and materials.

Develop details of design for structural work of moderate difficulty; prepare details of specifications; check structural drawings.

Instructor of engineering in a school or college even if of recognized standing; teaching (in any capacity) in a school which is not of recognized standing.

2. Typical examples of tasks which involve responsible charge of the character required of an applicant for the grade of Associate Member:

Execute intricate and extensive surveys with all details for finished map; make more difficult office computations; inspect and edit maps; execute difficult, important, and responsible geodetic surveys incident to topographic work.

Have charge of major public-land and related surveys involving complicated re-surveys, restoring original township, range, and state boundary lines.

Review and revise layouts, or detailed plans, specifications, or instructions, for the design, construction, and operation of works such as locks, dams, water and sewer systems; supervise construction of such works.

Plan working details, carry out, and report on a moderately difficult research or materials testing project; plan and conduct test on unusual specimens; interpret test results.

Design structural features for large steel and concrete buildings of considerable size or complicated type; supervise subordinates preparing working drawings.

Assistant professor of engineering in a school or college of recognized standing.

3. Typical examples of tasks which involve responsible charge of the character required of an applicant for the grade of Member:

Have charge of preparation of plans, specifications, estimates, and data of complicated cadastral surveys of considerable importance; serve as expert or consultant in the most difficult cadastral engineering problems.

Plan and direct difficult or complex field research or investigations of considerable economic importance relating to water supply from underground or surface sources for municipal or other use.

Have supervision of location, design, and construction of national park and national forest highways in an important subdivision of a field district, or of an important highway project.

Have charge of an important materials laboratory or of a major division of a large and important laboratory engaged in inspection, testing, and development of materials and equipment, and preparation of reports thereon and of specifications for purchase.

Direction of design of large steel and concrete bridges, buildings, or other structures of considerable importance; supervision of subordinates making design of structural features.

Associate professor of engineering in a school or college of recognized standing.

ADVICE AND COUNSEL OF MEMBERSHIP NEEDED

Maintenance of high standards of membership requires that any doubt as to the ability or character of an applicant be resolved in favor of the Society. To the Committee on Membership Qualifications has been given the responsibility of reviewing and reporting upon all applications, and it will be materially aided in the proper discharge of this duty by the advice and counsel of the membership at large.

New Sewage Treatment Works at Niagara Falls

Imposing Structure in River Gorge Resembles Power Plant; Both Layout and Equipment Are Unusual

By P. B. Streander

Member American Society of Civil Engineers
Consulting Engineer, New York, N.Y.

"*An unusual plant to meet unusual conditions"—thus Mr. Streander describes the sewage treatment works recently completed at Niagara Falls. The nature of the sewage (80 per cent industrial wastes) and the peculiar topography of the plant site were controlling factors in the design. Of special interest are the "screen filters"—fine screens to which a thin mat of coke breeze is continuously applied to improve the action. Other steps in treatment include sludge-incineration (which is aided by the presence of the coke) and chlorination.*

Interception, collection, and treatment of the sewage at Niagara Falls, N.Y., is a part of the general program to abate pollution of boundary waters along the so-called Niagara frontier. Plans for the work were begun in 1933, pursuant to a pollution-abatement order issued by the State of New York, and the plant was completed in October 1938 and placed in full operation in December.

The preliminary survey indicated a number of unusual conditions. The city of Niagara Falls lies on the north and east side of the river, partly above and partly below the Falls (Fig. 1). Its westerly part is on the escarpment above the Niagara River gorge, between 275 and 300 ft or more above the river level. The city is sewered on the combined plan, and in 1933 the sewage entered the river through eight outlets. (All but two of these are shown in Fig. 1.) Three of these outlets—including the extreme northerly and southerly ones, which transport the major part of the flow—were tunnels between 80 and 120 ft deep. The wastes from the city were largely of industrial origin, the ratio of industrial wastes to domestic sewage being about four to one, and studies indicated that it would be very costly to separate the two wastes.

Under such conditions the planning of a system of collecting sewers and a treatment plant presented many problems not generally met with in this type of work. The first of these was the determination of an economical location for the plant. Many sites were available, but almost all of them were 125 ft or more above any centralized collecting sewer outlet, and such a location would necessitate the pumping of the entire flow. Sites for gravity-flow plants were limited to available space in the gorge—and they were indeed quite limited.

The only space found that would provide the necessary area was a plot about 600 ft long and 200 ft wide, directly between the river's edge and the bottom of the rock cliff—the width of 200 ft being on a slope of about 40 deg. This plot of ground was almost immediately adjacent to residential areas, so that any type of treatment plant built would of necessity have to be such as would produce practically no odors, or would have to be fully enclosed. Consideration was given to the possiblity of extending the outfall sewer to a location above Lewiston where the escarpment falls off to flat lands, but such an extension would have required the building of a long sewer in tunnel and would have been too costly. The gorge site was accordingly selected.

The character of the waste liquids—the second "unusual" problem—precluded the adoption of any of the so-called standard methods of sewage treatment, as the large volumes of industrial sludges would seriously affect the operation of settling tanks and of sludge digestion tanks. It was also indicated that the sludge would be difficult to handle and treat in the raw state. Nevertheless, preliminary plans were made based on the use of settling tanks for partial removal of the solids, and mechanical dewatering and incineration of the sludge. Estimates showed the cost of such a plant to be prohibitive, and economically unreasonable for the degree of treatment to be effected.

In view of these related but conflicting conditions it was decided that a sanitary survey of the river might disclose facts which would help solve the problem. Accordingly the city engaged Dr. Willem Rudolfs, M. Am. Soc. C.E., to conduct such a survey. Samples were collected and analyses made of the river water at Goat Island, at the Three Sisters' Island above the Falls, and at Lewiston below the rapids. During the sampling periods the average river flow was about 150,000 cu ft per sec (about 40,000 cu ft per sec below normal). The results of the analyses showed a dissolved oxygen content of between 96 and 97 per cent above the Falls, and 105 per cent, or supersaturation, below the rapids. Obviously the river was in a condition to take care of

A View of the Niagara Falls Sewage Treatment Works from the Canadian Shore

The Two Wings House the Filters, and in Front of Them Are the Contact Tanks. Behind the Main, or Central, Building Are the Grit Chamber and Bar Screens

a considerable pollution load. There was practically no change in the 5-day B.O.D. of the river within the area surveyed, it averaging about 2.8 ppm above the Falls and below the rapids. Calculations showed that the 5-day B.O.D. load in the river below the city required about 21 per cent of the total oxygen in the river, which would leave 84 per cent saturation. This was on the basis of raw sewage being discharged into the river from Lake Erie to Lake Ontario, a condition that will be materially changed by the completion of the various other treatment plants involved in the pollution-abatement program.

The report covering the sanitary survey concluded that only partial treatment was required, consisting of removal of coarse suspended and floating materials and disinfection. "Partial treatment" was interpreted by the State Department of Health as requiring removal of about 30 per cent of the suspended solids, or removal of such sewage particles as could not be effectively chlorinated. During the period of the sanitary survey gagings were made of the sewage flow as well as analyses of the sewage and wastes. Sewer gagings gave the average volume of liquids to be treated as between 65 and 75 mgd from a population of about 75,000. Studies showed that, of this total, 50 to 60 mgd consisted of industrial wastes, and that the loading based on a suspended solids content was equivalent to a population of about 650,000.

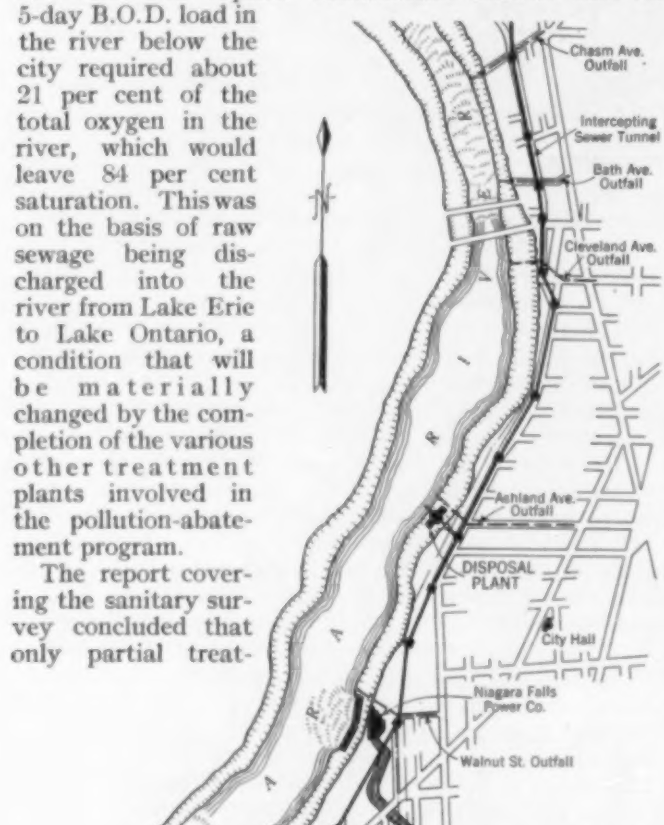


FIG. 1. PART OF THE CITY OF NIAGARA FALLS, SHOWING LOCATION OF OLD SEWAGE OUTLETS, AND NEW INTERCEPTORS AND TREATMENT PLANT

The Interceptor Extends Some 3,600 Ft Beyond the Northern Limits of This Map

When the various facts determined by the river survey were available, studies were made of the possibility of using fine screens for the removal of the floating and coarse suspended solids. Estimates indicated that the cost of such a plant would be about one-half that of a plant with settling basins. Studies of screen behavior also indicated that plant operation would not be upset by industrial wastes; however, it appeared that fine screens could not effect removal of the required amount of solids.

It was then recalled that some experiments had been made in 1928 at the Jamaica (New York City) fine screening plant, using an artificial mat to increase the amount of solids removed. The result of these experiments indicated that removal of between 40 and 50 per cent of the settleable solids had been obtained. Following the Jamaica test by several years, one of the fine screens at the South Norwalk, Conn., plant had been temporarily constructed into a so-called "screen-filter," using a superimposed layer of coal. It also showed a comparatively high removal of settleable solids, tests having given results varying between 50 and 80 per cent.

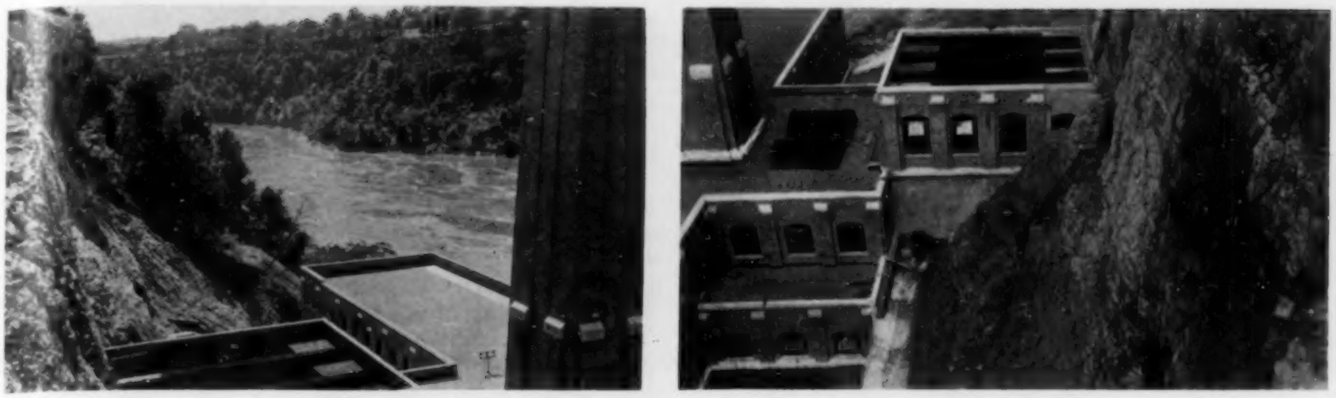
ADVANTAGES OF THE "SCREEN-FILTER"

This method of treatment was carefully studied to see if it would not meet the requirements at Niagara Falls, and the conclusion was finally reached that it would effect a removal of between 25 and 35 per cent of the suspended solids, and that the effluent could be effectively sterilized. Such a degree of treatment would meet the stipulated plant requirements. The method had the further advantages (1) that the treatment plant could be fully housed in, to confine odors; (2) that the sludge produced, instead of containing from 2 to 3 per cent solids, would have 15 to 20 per cent solids; (3) that industrial wastes would not interfere with sludge treatment; and (4) most important of all, that the area required by such a plant met the imposed and given site conditions. In addition, the use of coal or similar material for the filter medium would provide the fuel needed to evaporate the moisture and burn the sewage solids. This method of treatment was therefore adopted with incineration of the sludge or screenings. The plant being a mechanical one, the specifications and contract were prepared on the basis of guaranteed plant performance for solids removal and disposal.

The sewage and wastes are collected in an intercepting sewer tunnel having a total length of about 18,000 ft. This tunnel is built in rock and has a depth varying between 85 and 140 ft. The interception of the sewage presented the problem of either building individual regulating chambers having depths of between 80 and 120 ft, or building a single regulating chamber and intercepting larger volumes of flow from the individual outfall sewers. Consideration of operating conditions indicated that a single regulating chamber was preferable. The intercepting sewer was designed to provide a capacity of about 260 mgd, which is about five times the rate of the dry weather flow. Simple dams of concrete and brick masonry were built in the existing deep sewer tunnels to divert the sewage into the intercepting sewer tunnel. The few surface outfall sewers were intercepted in the same manner and drop pipes 24-in. in diameter were drilled to the intercepting tunnel.

HARMLESS WASTES AND EXCESS STORM FLOWS DIVERTED

A considerable part of the industrial wastes discharged into the city sewer system consisted of cooling and rinsing waters and other wastes not harmful to the river. To reduce the capacity of the treatment plant, and its capi-



FROM THE NEW YORK SIDE OF THE RIVER, ONLY A BIRD'S-EYE VIEW OF THE PLANT CAN BE OBTAINED

tal and operating costs, a diversion sewer was built to carry directly to the river such wastes as could be economically reached. This sewer diverts about 20 mgd from the city sewer system and reduces the flow to the plant to between 50 and 60 mgd.

Regulation of flow is effected at the plant by means of a so-called master regulator and overflow chamber under the direct control of the plant operator. Briefly it consists of a vertical venturi tube, used to measure the amount of sewage entering the plant, and an automatically controlled valve (placed below the venturi tube), operated jointly by the level of sewage in the control chamber and the rate of flow through the meter. The regulator has an extreme maximum capacity of 120 mgd but is now set to allow the discharge to the plant of a maximum rate of 90 mgd. During periods of storm the regulator automatically throttles the rate to this amount, causing all excess flows to discharge over weirs into the by-passes around the plant. The regulating chamber was designed to handle flows up to 400 mgd but under actual surcharged conditions has handled almost 600 mgd.

The site presented many difficulties in plant arrangement and design, and in construction as well. The type of plant installed, which can best be described as an unusual one to serve an unusual condition, is in reality a fine screening plant, the treatment results of which have been improved by the placing of an artificial mat over the screen surfaces.

A section through the plant and its access tunnels is shown in Fig. 2. The plant is entered through a small building located on Whirpool Avenue, which runs parallel to the river. Stairs lead thence to a tunnel constructed under the New York Central tracks and extending to an elevator shaft on the opposite side of the tracks. Here a concrete-lined circular shaft, 16 ft in diameter, was sunk to house a service and freight elevator. The total elevator travel is about 135 ft from the top of the shaft house to the floor of the entrance tunnel leading to the plant. The elevator has a capacity of 12,000 lb and was made large enough to handle any equipment coming to or from the plant.

The plant is all one structure, but is divided into three parts—the north and south wings, housing the screen filters, and the central or main building, the lower floors of which house the incinerators. The top floor of the main building houses the chlorinating equipment, the office, and laboratory and control rooms. Two control panels are provided, one for each filter wing, on which are mounted all switches leading to the various motor controls, and all the indicating and recording instruments of the plant. The entire operation of the plant can be visualized from these panels.

Sewage passing the regulating chamber goes through grit chambers and then flows to the two wings, three screens being provided in each wing.

Each screen is 22 ft in diameter and has a screening area of about 300 sq ft, with $^1/_{32}$-in. slots and an open area of about 40 per cent. The screens can be operated either as fine screens or as so-called screen filters.

COKE BREEZE USED AS FILTER MEDIUM

Under the latter option an artificial mat is applied to the surface of the screen to filter out and retain a greater amount of the fine solids. In the various tests conducted, and in partial plant operations, it was found that coal clogged rapidly, owing to the extreme fineness of the sewage and waste solids. Following considerable experimentation with various thicknesses of coal mats, methods of removal, sizes of coal, and so forth, the use of coal has been tentatively abandoned and the plant will be operated using a so-called coke breeze as the filter medium.

As shown in Fig. 3, the coke is stored in

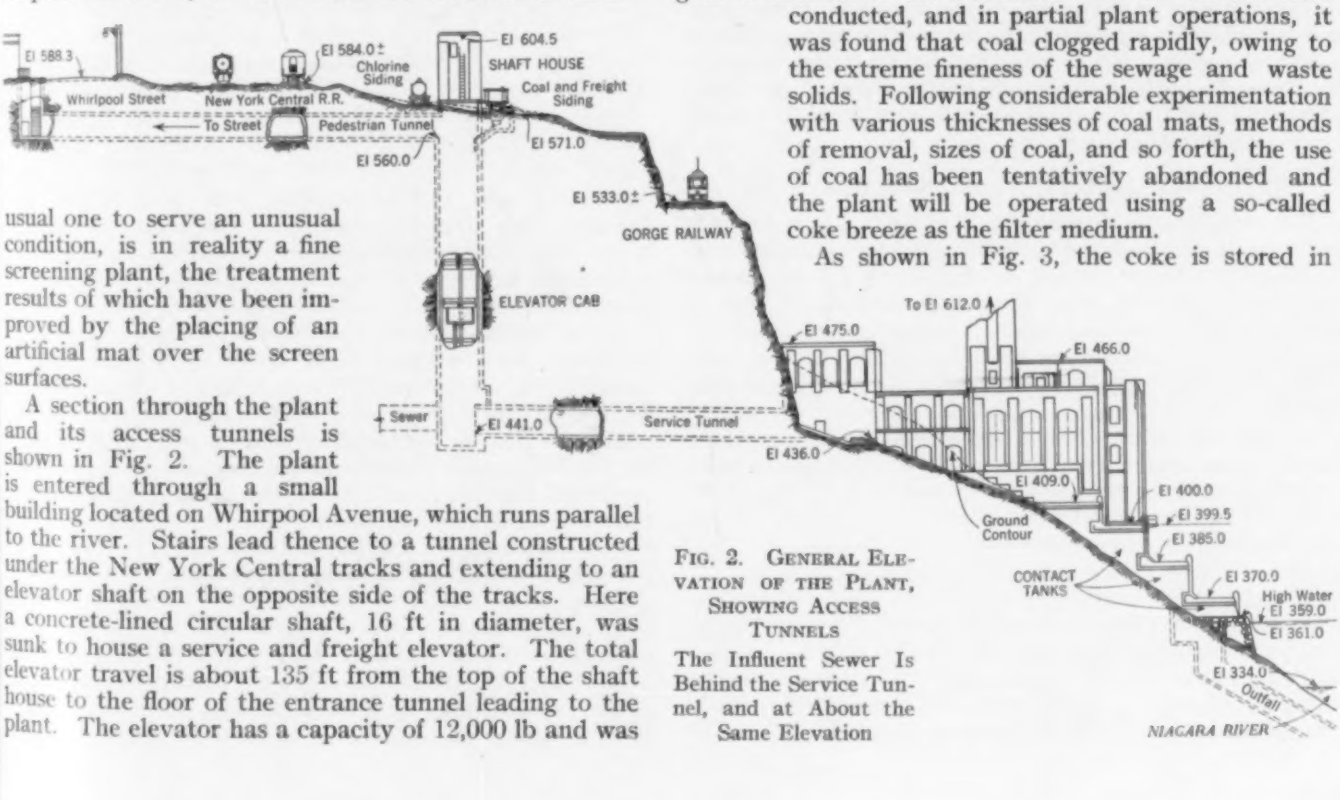


FIG. 2. GENERAL ELEVATION OF THE PLANT, SHOWING ACCESS TUNNELS

The Influent Sewer Is Behind the Service Tunnel, and at About the Same Elevation

bunkers and conveyed thence to the storage hopper above each screen. The bottom of the storage hopper has an adjustable gate and an adjustable leveling blade to vary the thickness of the mat. Present operating results indicate that a mat about $^3/_8$ in. thick will effect the required solids removal without unduly reducing the capacity of the screens. The plant is so arranged that all the dry-weather flow will pass through the screen filters. When storm flows occur, use of the filter medium will be discontinued and the mechanisms will be operated as fine screens, taking flows up to 90 mgd. Flows in excess of this amount are automatically by-passed, joining the plant effluent to the river.

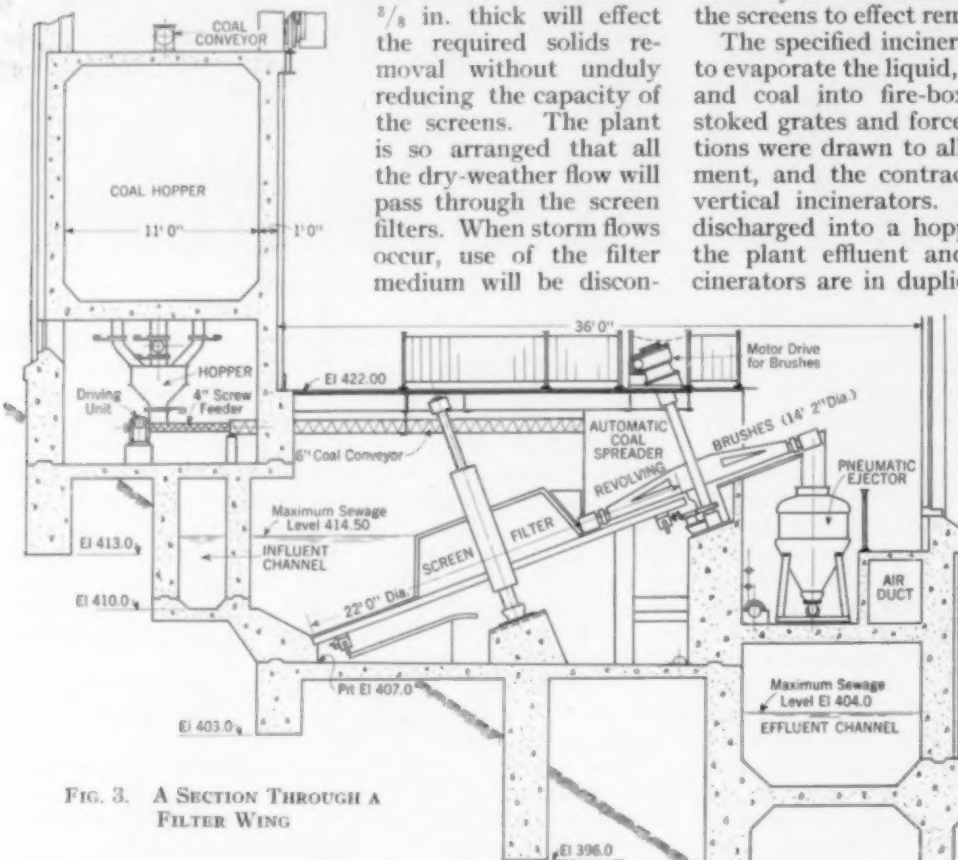


FIG. 3. A SECTION THROUGH A FILTER WING

The effluents from the two screen filter wings discharge into six chlorine contact tanks, each 15 ft wide by 90 ft long and constructed in two batteries of three compartments each, built in steps below the filter wings. The effluents from the two batteries are combined in a common outfall to the river.

CHLORINATION AND INCINERATION

Chlorine is used in tank-car lots, the car supplying it being kept on a railroad siding at the top of the escarpment. The liquid is fed to automatically controlled evaporators that convert it to a gas, after which it is piped down the elevator shaft to the service tunnel leading to the chlorinator room. Pre-chlorination is provided for odor control and post-chlorination for bacterial destruction.

All known safety factors have been incorporated in the chlorine installation to provide the fullest measure of safety in operation. The apparatus is designed to provide a daily capacity of 6,000 lb of chlorine. There are five chlorinators, each having a capacity of 1,500 lb per day, one of which is a spare or standby unit.

Sewage solids and coke breeze are swept from the screen filters by the rotating brushes and dropped from the brush trough into pneumatic ejectors. These ejectors discharge the material into storage tanks located in the central building. Originally the plans provided for centrifugal dewatering of the material so that it could be more readily burned, but it has now been decided to operate the plant without the dewatering equipment. This naturally places a greater load on the incinerator, but tests indicate that the additional moisture can be evaporated by the heat contained in the coke breeze used on the screens to effect removal of the finer suspended solids.

The specified incinerators consisted of rotating drums to evaporate the liquid, which discharged the dried sludge and coal into fire-boxes provided with mechanically stoked grates and forced draft. However, the specifications were drawn to allow the use of competitive equipment, and the contractor elected to install multi-zone vertical incinerators. Clinker from the incinerator is discharged into a hopper and automatically sluiced to the plant effluent and then into the river. The incinerators are in duplicate, each being provided with a waste heat boiler that generates steam for the heating of the building.

Considerable attention was given to the ventilation of the building, and a system of exhaust fans was provided with suction piping having connections made close to the surface of the sewage. The exhaust piping from the various fans connects into an annular space between the incinerator chimney and its containing tower. Fan capacity provided for the entire plant is about 90,000 cu ft per min.

As this is a strictly mechanical plant, the specifications require that, besides the various mechanical trials, the contractor is to conduct a 30-day permance test with the plant in full operation to determine compliance with the guarantees. This test, now in progress, will be completed in January 1939. Before it was begun, the plant was placed in partial operation for several weeks, to determine actual conditions, instruct the operating personnel, and secure a smooth working sequence of operation.

Work in constructing the plant was divided into five contracts, the total cost being about $1,400,000. This, for a flow of 50 to 60 mgd, is an average of about $25,000 per million gal capacity. Taking into account the unusual conditions surrounding the plant, particularly in the foundation requirements, difficulties in excavation, and the inaccessibility of the work, it is believed that this is a very reasonable cost—especially when it is considered that the plant not only effects about a 30 per cent removal of suspended solids but also completely destroys those solids.

The plant is not visible from the American side of the river. From the Canadian side it presents the appearance of a power plant, entirely belying its purpose. Up to the present time there have been no odors discernible from the plant, either close by or at more remote points.

Dual Parshall Flumes Measure Wide Range of Flows

By H. S. Riesbol

Junior, American Society of Civil Engineers

Associate Hydraulic Engineer, Soil Conservation Service, U. S. Department of Agriculture, Coshocton, Ohio

Looking Downstream from Entrance of Dual Flume

Measurement of the runoff of very small watersheds is complicated by the fact that the base flow may be less than 1 cu ft per sec, while the 100-year flood may be a thousand times as great. No single hydraulic device can cover accurately such an extreme range; hence a series of measuring units is required. Mr. Riesbol here describes the adaptation of Parshall flumes to such conditions, and explains why they were selected in preference to weirs on a number of small watersheds in eastern Ohio.

Parshall measuring flumes have been adapted, through combination, to the measurement of a wide range of flows in making watershed and hydrologic studies near Coshocton, Ohio. These studies relate to soil and water conservation, flood control, and runoff as influenced by land use and methods of erosion control in the North Appalachian Region, and are a project of the Section of Watershed and Hydrologic Studies, Division of Research, Soil Conservation Service, U. S. Department of Agriculture.

The combined flumes have been installed on areas of various sizes, the maximum expected discharges of which run from 80 to 1,000 cu ft per sec. In Table I, which describes typical watersheds from this group, characteristics are measured from available topographic maps, and expected runoffs are computed by the "modified rational method."[1] Flow from watersheds having a 100-year flood in excess of 1,000 cu ft per sec is measured by other types of controls which are rated by current meter gagings. When the 100-year flood is less than 80 cu ft per sec, one small measuring flume is used in conjunction with the Ramser silt sampler.[2]

Preliminary analysis of flow from these watersheds in relation to factors that affect the design of measuring equipment, brings out the following points of interest:

1. Base flow—that is, flow originating from groundwater supply—will probably continue over 90 per cent of the time. This conclusion is drawn as the result of observation of streams in the North Appalachian Region.
2. The maximum expected discharge is of brief duration, because of the smallness of the watersheds.
3. The type of flood-producing storm which occurs on the average of once each year produces discharges that are only a small fraction of the maximum expected discharge.
4. An average base flow ranging from zero to 1 cu ft per sec may be expected. The upper limit of 1 cu ft per sec is exceeded only immediately following storm periods.

If a limit of error of 2 per cent is set in measuring the flow from these watersheds, the allowable error in 1,000 cu ft per sec is 20 cu ft per sec, while for a discharge of 1 cu ft per sec it is only 0.02 cu ft per sec. Since no known practicable hydraulic device will accurately measure such an extreme range of discharge, the immediate conclusion is to pass the flow from any given watershed through a series of measuring units each having a range of measurement such that the error will remain within the desired limits. Additional requirements for the measuring units, as dictated by local conditions, are:

1. The selected device must have minimum susceptibility to velocity of approach. The typical channels of the North Appalachian watersheds are steep in profile and variable in cross-section; consequently velocities are high, cover an extreme range from minimum to maximum flow, and are erratic in manner of occurrence. Any attempt to correct discharge measurements for such velocities of approach will be subject to uncertainty and inaccuracy.
2. The selected device must handle flows that carry a heavy debris load, capable of filling any stilling pool placed in the stream channel.

These two requirements preclude the use of measuring weirs, either sharp or broad-crested.

Advantages of the Parshall Flume

Tests made at the Colorado Experiment Station[3] on a standard Parshall measuring flume of 2-ft throat width indicated that an increase of 300 per cent in the velocity of approach to the flume did not cause the individual measurements to deviate more than 5 per cent from the established rating curve. It is pointed out by Parshall that the velocities used in these tests were all moderate, and that if conditions are such as to cause high velocities in the approach channel, a flume of narrow throat width should be installed so as to increase the depth of flow and reduce the velocity of the stream.[3] The Parshall flume will also handle debris-laden water better than most other hydraulic measuring devices because flow through the flume accelerates until it becomes critical at the crest, this velocity being sufficient to keep the crest clean under ordinary conditions. These recommendations, in addition to the availability of detailed and accurate ratings of the head-discharge relationship for flumes of different capacities, suggested the Parshall measuring flume as being probably the best hydraulic flow measuring device now available for use on the watersheds described in Table I.

On the basis of the watershed flow characteristics just mentioned, it appears that the flume having the throat width required to measure peak flood flow from a given watershed should have an accurate and predetermined gage-height–discharge rating which can be confirmed with a limited number

Table I. Characteristics of Typical Watersheds and of Flumes Selected

Watershed Number	Watershed Characteristics: Area, Acres	Slope, Ft per 100 Ft	Length, Ft	Cover	Estimated Maximum Runoff, Cu Ft per Sec	Throat Width, Ft: Main Flume	Supplemental Flume	Head Required in Main Flume to Carry Maximum Flow, Ft	Minimum Flow That Can Be Accurately Measured in Main Flume, Cu Ft per Sec
F-10	135	..	3,220	Mixed	671	15	1.0	4.63	8.00
F-183	74.2	14.8	3,280	Mixed	388	8	0.75	4.70	4.62
F-172	43.6	22.8	1,980	Timber	150	4	0.50	4.15	1.26
F-168	27.3	13.2	1,450	Mixed	232	4	0.50	5.50	1.26

of current-meter discharge measurements. It also appears that base flows should be measured by a small and previously rated supplemental flume having sufficient maximum capacity to overlap the minimum point of allowable accuracy on the curve of discharge for the large flume. The use of some type of sharp-crested weir in place of the small flume was considered but not adopted because of the possibility that the crest would become covered with trash and the approach pool filled with debris.

LOOKING UPSTREAM AT DUAL PARSHALL MEASURING FLUMES

Large and Small Flumes Have Throat Widths of 15 Ft and 1 Ft, Respectively. Note Gage House in Right Background

To the writer's knowledge, the first attempt to combine Parshall measuring flumes of different throat widths in order to cover a wide range of expected discharges with uniform accuracy, was made by Colin A. Taylor and Harry G. Nickle, Associate Members, Am. Soc. C.E., of the Bureau of Agricultural Engineering of the U. S. Department of Agriculture.[4] Their design was for flumes having much less capacity than those required in the Coshocton studies, but the basic principle involved is identical. Engineers of the California Forest and Range Experiment Station also found it desirable to design combined units for installation in the San Dimas Experimental Forest.[5] The designs adopted on the San Dimas project involved modification of the recovery section of the standard Parshall measuring flume, and utilized a 90-deg V-notch weir for the measurement of small continuous flows.

LOCATION AND PROPORTIONS OF SMALL FLUME

Several schemes have been considered for the proper placement of the small supplemental flume in relation to the large one so as to secure accurate measurement during both rising and falling stages, within the limits of capacity of each flume. Placement of the small flume directly in the channel, either upstream or downstream from the large flume, is considered impracticable because of the possibility that the small flume will become clogged with rock and other debris during the falling stage of flood flows. The use of a pipe to transfer the low flows from the large to the small flume was considered, but not adopted—for the same reason, and also because of excessive construction cost. The side outlet from the recovery section of the large flume, as adopted by Taylor and Nickle in their California study,[4] appears most practicable on the large structures required at Coshocton. The accompanying photographs and Fig. 1 illustrate the physical relation of the two flumes to each other.

Several reasons make it necessary to choose the narrowest feasible throat width for the larger flume:

1. Increasing the depth of flow in the flume decreases the slope of the water surface in the channel upstream from the flume entrance, thereby decreasing the slope of the energy gradient and the velocity of approach.

2. Increasing the depth of flow through the flume increases the maximum velocity attained in the flume, since $V = \sqrt{gd_c}$, where V is the mean velocity and d_c is the depth (critical) attained in the flume. The increase in velocity will aid the passage of heavy debris.

3. The narrower the throat width of the selected flume, the smaller the minimum discharge that can be accurately measured. This permits the use of a smaller supplemental flume with consequent greater accuracy in base-flow measurements.

The maximum depth of flow that can be measured by a Parshall flume and still make use of the discharge formula derived by Parshall has not been definitely determined. Since facilities are not available for a series of tests, it has been deemed advisable to limit the maximum head selected for each flume to the actual maximum discharge measurement available for flumes of that throat width.[6]

The selection of throat width for the supplemental flume is determined by the minimum discharge that can be accurately measured by the selected large flume, this being set as the maximum capacity of the small flume. These small flumes also have a lower limit in the tables of discharge,[3] but since in the dual installation they are subject to no submergence and since the base flow carries no debris load, it is possible, after installation, to rate each individual flume to practically zero flow by the use of a stop watch and cubic-foot buckets for volumetric readings. The composite rating curve for a 15-ft flume with a 1-ft supplemental flume is shown in Fig. 2.

Scale models of the flumes as finally designed have been constructed and actual flow tests made on them in a temporary testing channel by Chester Woo, Jun. Am. Soc. C.E. The tests were made to secure more definite data on the following points in the design of the individual flumes:

1. The flow capacity of the side outlet to the small flume.

2. The design of the entrance basin to the small flume.

3. The location of the nappe of flow at the outlet of the large flume, in order that a spill basin might be properly designed.

The capacity of the side outlet and the design of the entrance basin to the small flume, as used in conjunction

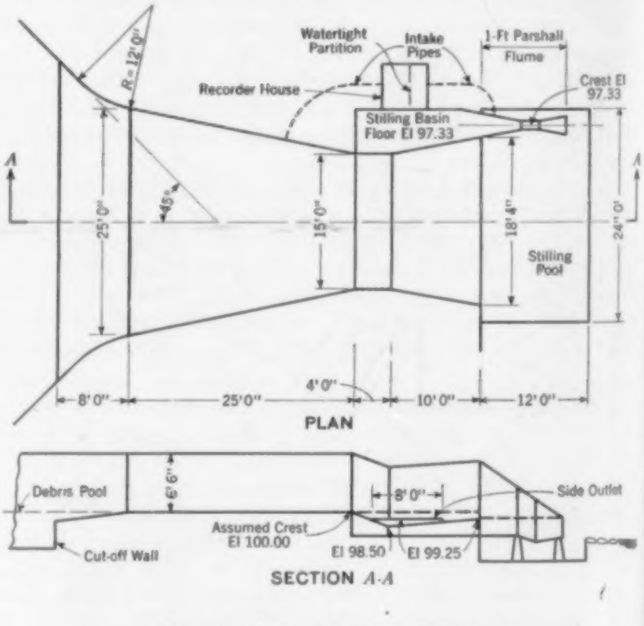


FIG. 1. DUAL PARSHALL FLUME

Dimensions Shown Permit Accurate Measurement of Flows of 0.10 to 8.0 Cu Ft per Sec in Smaller Flume and 8 to 1,000 Cu Ft per Sec in Larger Flume

with a Parshall measuring flume of 15-ft throat width, were checked in a model having a scale ratio of 1:8. Sufficient flow was available, and was measured in the test channel by means of a 90-deg V-notch weir, to more than cover the range of base flow to be handled by the supplemental flume and side outlet, but not enough to test the full range of capacity of the large flume.

The theoretical capacity of the side outlet has been computed by the theory of critical flow over an overfall, which states that maximum discharge for a given total head will occur with total or specific energy at a minimum. The maximum discharge in a V-shaped channel as derived by Horace W. King, M. Am. Soc. C.E. (in his *Handbook of Hydraulics*), is $Q = 2.295\ z\ H_e^{5/2}$, where z is one-half the width of the water surface at depth d, divided by d, and H_e is the total head from channel invert to water surface, neglecting velocity of approach. Using this formula, a side outlet with an area of 4.48 sq ft and a head, H_e, of 0.25 ft, would have a maximum discharge of 8.95 cu ft per sec.

ACTION OF SIDE OUTLET STUDIED IN MODELS

As determined from model tests, the maximum discharge through the side outlet for any stage of flow in the 15-ft Parshall measuring flume was actually 9 cu ft per sec (Fig. 3). During the rising stage the velocity of flow in the diverging section of the larger flume is sub-critical until a discharge of approximately 53 cu ft per sec is attained, and above this point the velocity is super-critical. During the falling stage the velocity in the diverging section is super-critical until a discharge of approximately 38 cu ft per sec is reached and below this point the velocity is sub-critical. This difference in energy transition points between rising and falling stages is probably due to opposing effects of inertia and gravity. Sub-critical velocity of flow in the diverging (recovery) section is characterized by roller action in

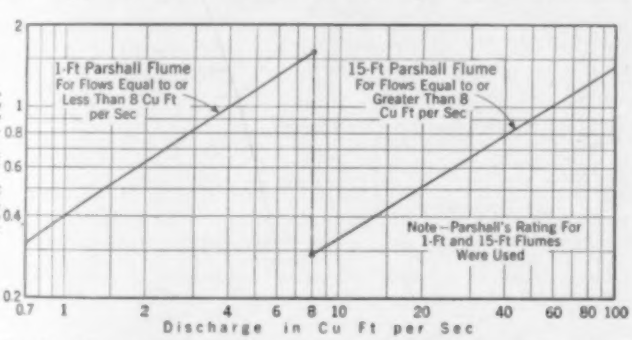


FIG. 2. HEAD-DISCHARGE CURVE OF DUAL PARSHALL FLUME
Parshall's Ratings for 1-Ft and 15-Ft Flumes Were Used

the dip, while super-critical velocity is characterized by a smooth surface curve. When the velocity in the recovery section of the large flume is super-critical there is practically no flow through the side outlet.

The use of a flume of narrow throat width tends to decrease the velocity of approach of flood flows from steep areas to the flume entrance, which results in the deposition of rock and other erosional debris. If this change in hydraulic gradient is too close to the flume entrance, deposition will occur in the converging section of the flume, thereby destroying its accuracy. In order to work out a method for preventing this deposition, a reconnaissance was made of the debris cones formed at those points where watersheds similar in size to those proposed for measurement empty their flow onto the main valley floor. It was found that in the Coshocton area the debris cones formed at these points are rarely over 125 ft in length and that all the material of boulder size is usually deposited within the first 50 ft. In accordance with this information it was decided to place the crest of each of the large flumes above the present stream profile a sufficient distance to flatten the hydraulic gradient of the stream at a point not less than 125 ft above the flume entrance.

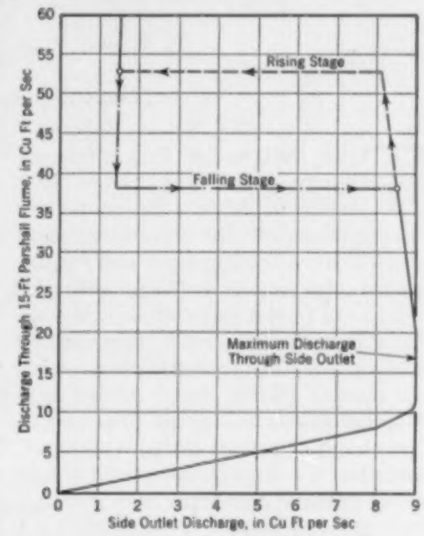


FIG. 3. RELATION OF FLOW THROUGH SIDE OUTLET TO FLOW IN 15-FT FLUME (FROM TEST DATA)

This means that the crests of the flumes are from 2 to 5 ft above the present stream profile. This provides for the dropping of all heavy debris in the stream channel a considerable distance upstream from the converging section of the flume. The deposits can be removed from time to time as required.

The pool that actually formed immediately upstream from the entrance of the flume shown in the illustration at the head of this article, filled during the first storm after it was built. This filling is desirable because the presence of a pool causes some inaccuracy in determining the time at which runoff begins, and because the change in channel slope, rather than pool action, is depended upon to cause deposition of debris load.

Measurements of head in the large flume and in the small supplementary flume are made in separate stilling wells located immediately adjacent to each other under an instrument shelter. The two head measurements are recorded by two vertical drum water stage recorders. The stilling wells are connected with the flumes by pipes of such diameter that there is no appreciable head loss due to movement of water through the pipes during rapidly rising or falling stages.

All the flumes are built of reinforced concrete, and are supplied with an adequate underdrainage system to prevent the development of uplift pressure or the accumulation of water which might cause pressure due to freezing.

Since the first dual Parshall measuring flume on the Coshocton project was completed, no storms have occurred to produce enough runoff for satisfactory field tests of the installation. When such storms do occur, field observations and current-meter ratings of the discharge through the flumes will be made.

REFERENCES

1. "Planning Small Water Storage Projects—Design of Low Dams," Appendix A, Second Preliminary Draft, prepared by the Subcommittee on Small Water Storage Projects, National Resources Committee.
2. "Soil Erosion Control on the Federal Projects," by C. E. Ramser, *Agricultural Engineering*, April 1930.
3. "The Parshall Measuring Flume," by Ralph L. Parshall, Bulletin 423, Colorado Experiment Station.
4. "Water Losses under Natural Conditions from Wet Areas in Southern California," Bulletin No. 44, South Coastal Basin Investigation, Division of Water Resources, Department of Public Works, State of California, Part I, Chapter IV.
5. "Measurement of Debris-Laden Stream Flow with Critical-Depth Flumes," by H. G. Wilm, John S. Cotton, and H. G. Storey, *Proceedings, American Society of Civil Engineers*, September 1937.
6. "Parshall Flumes of Large Size," by R. L. Parshall, Bulletin 386, Colorado Experiment Station, Fort Collins, Colo.

Hydro Power Plant Space and Cost Trends

Comparative Study Points Way to New Economies in Design

By H. G. Gerdes

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The results of a ten-year study of hydro plant costs, concisely presented in the accompanying article, should bring even the casual reader to share Mr. Gerdes' opinion that the economic factors of plant design are too little considered. Both text and charts merit the closest attention of the hydroelectric engineer, and should serve a valuable purpose in indicating the relative worth of new designs as compared with those embodied in older installations. The paper was given before the Power Division at the 1938 Fall Meeting.

The motive for this study of hydro plant costs arose first from a desire for more accurate cost data for estimating, and later from a feeling that the fundamental factors governing the economics of power plant design are too little considered. Still later came a realization that construction costs on similar plants have varied materially without a great deal of difference in the utility of the product, and that a comparative study would show these differences and indicate the most desirable practices.

Cost in terms of the customary engineering units of quantity, such as the cubic yard, when applied to comparable structures, is a measure of the cost-efficiency of construction, but not of design. Indeed the unit cost of construction may be lowered by a lax design in which a simpler, more bulky construction is substituted for a smaller but more refined one. For hydroelectric power plants, the appropriate unit by which to measure both design and construction efficiency in terms of cost appears to be the installed capacity in kilowatts, and accordingly this unit has been used for the general comparisons in this study.

An effort has been made to compile all cost data on the same basis—that of total construction cost. This includes all payments for material, labor, construction plant, and superintendence, but excludes engineering, administration, interest, and taxes during construction. On some of the plants listed here, the work was done by fixed or unit-price contracts, and on these the payments to the contractors constitute the total construction cost. On others the work was done by day labor or by cost-plus-fee contracts, involving large indirect construction expenditures for plant temporary construction, and so forth. Where these indirect expenditures were not so allocated in the original data, they have been distributed over the direct construction costs as a uniform percentage of the direct labor charge, in order to arrive at total construction costs.

The plants covered by this study are listed in Table I, with miscellaneous data that will be discussed later. All these plants have been planned and built during the last three decades. Cost analyses, with one exception, have been confined to plants built during the last twenty years. Many of the cost figures and quantities have been derived from the public cost statements of licensees to the Federal Power Commission. These reports, undigested and difficult of analysis as many of them are, still form the most available source of such data.

The head taken as the basis of comparison is the average gross operating head between plant headwater and tailwater. For river-run plants this is close to the gross static head. For plants at storage dams it will ordinarily approximate the gross static head less one-fourth of the maximum drawdown. For plants with long flow conduits the headwater level has been taken as the average water-surface elevation in the surge tank.

COST SPER INSTALLED KILOWATT; WHAT THEY INCLUDE

Cost per installed kilowatt for a number of modern hydro plants is shown in comparative form in Fig. 1. The costs indicated are those attaching to the operating units, the number of which is shown as of the date of the analyses. Expenditures on account of future units have been excluded; that is, the unit costs shown bear only an equitable proportion of the expenditures made in part for the benefit of future units. The resulting capacity unit cost is the same as though the power plant were completed to ultimate capacity at the structural unit costs of the initial construction.

Table I. Plants Analyzed, with Miscellaneous Data on Size of Units and Cost of Substructure

Power Plant	Avg. Head at Full Load	Kw. per Unit at 90% P.F.	Unit Spacing in Ft	Date of Construction	Substructure Costs, per Cu Yd: Concrete in Place*	Excavation: Rock	Excavation: Earth	Type of Rock
Marmet, W.Va.	23	5,100	50	1934–35	....	$1.51	$0.61	Sandstone
London, W.Va.	23	4,800	50	1934–35	$14.00†	1.52	0.76	Sandstone
Albany, Ga.	25	2,025	34	1919–21	26.00	3.00	0.59	Limestone
Winfield, W.Va.	27	5,800	50	1936–37	....	...	...	.....
Rock Island, Wash.	32	15,000	68	1930–32	21.00†	3.07	1.00	Igneous
Monroe, Nebr.	32	2,600	33	1934–37	....	...	0.50	Sand
Keokuk, Iowa	34	8,100	48.5	1912–	....	...	...	.....
Chickamauga	47	27,000	80	1936–	....	...	...	.....
Wheeler	50	32,400	76	1935–37	....	1.84	...	Limestone
Safe Harbor, Pa.	53	32,400	62	1931–32	19.00†	3.37	...	Gneiss
Pickwick, Tenn.	55	36,000	80	1935–38	....	...	...	.....
Bonneville, Ore.	56	43,200	82	1934–38	....	1.76	0.80	Basalt
Lay, Ala.	68	12,200	48	1913–14	....	...	...	.....
Conowingo, Md.	89	36,000	72	1926–28	19.00‡	9.20	4.40	Granite, gneiss
Jordan, Ala.	90	25,000	60	1926–28	....	...	...	.....
Wilson, Ala.	92	22,500	55.5	1918–26	17.00‡	5 57	0.73	Hard cherty limestone
Bagnell, Mo.	95	21,500	56	1929–31	12.00‡	8.58	0.59	Chert, dolomite, limestone
Bartlett's Ferry, Ga.	114	16,875	42.7	1924–26	22.00‡	4.63	1.21	.....
Columbus, Nebr.	112	13,300	37	1934–37	....	...	0.40	Sand
Martin, Ala.	133	33,000	56	1923–26	15.00‡	...	...	Mica schist
Oneida, Utah	140	10,000	32	1913–20	16.00‡	1.99	1.45	.....
Saluda, S.C.	168	36,600	46	1927–30	....	...	...	.....
Norris, Tenn.	178	50,400	60	1934–36	....	...	...	.....
Ariel, Wash.	181	50,600	60	1930–31	9.50‡	1.99	0.54	Andesite, basalt lava
Wallenpaupack, Pa.	330	22,500	40	1924–26	23.00‡	6.82	3.83	Sandstone schist
Waterville, N.C.	760	40,500	54	.....	....	...	...	.....
Oak Grove, Ore.	850	28,700	35	1921–24	....	...	...	Basalt lava

* Including forms, steel, and cement. † Reinforced concrete. ‡ Semi-reinforced concrete.

The costs stated constitute the total construction cost of the power plant building, the intake (if integral therewith), and the hydraulic, low-tension electric, and miscellaneous equipment. They do not include the cost of high-tension switching equipment and transformers. The kilowatt capacity is based either on a 90 per cent generator power factor or on the limiting turbine capacity, whichever is the lower. It is believed that the plants shown are fairly comparable in cost in an economic sense. Most of them were built during a period of generally stable prices. All except Oak Grove are located at fairly accessible sites. Most of them are situated in the beds of rivers of some magnitude.

Approximate formulas indicating the general trend of total construction cost are also included in Fig. 1.

SUBDIVISIONS OF PLANT COSTS

In order to secure uniformity of treatment of the various power plants it was necessary to set up definitions of the parts of the plant to be included in each subdivi-

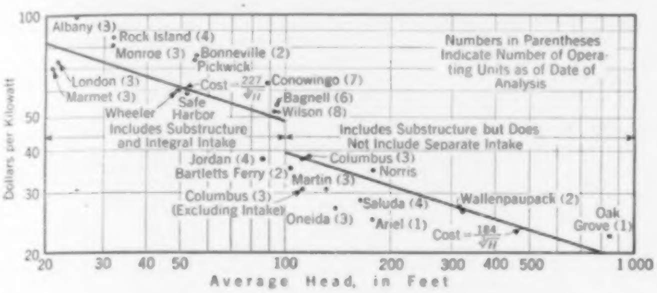


Fig. 1. Comparative Hydro Power Plant Costs

sion. The cost accounting system to which these definitions apply has been adopted by the Federal Power Commission as a standard for hydroelectric construction of licensed water power projects, being Schedule 6 of Form 45, "Initial Statement of Actual Legitimate Original Cost," issued by the Commission.

Account 321.1–.4. Intake and Substructure.—This group of subaccounts covers the cost of the power plant intake, where integral (as at Bonneville and Wilson); substructure; power plant cofferdam (or part of cofferdam applicable to power plant); integral intake gates and trash racks; and draft-tube gates. Where the power plant and integral intake form a section of the dam, the intake and substructure (as distinguished from superstructure) are defined as the generally solid block structure upstream from the downstream face of the intake wall and below the generator floor level. Where the power plant is separate from the dam, or lies against the downstream face of an otherwise separate dam, as at Martin or Norris, the power plant substructure is taken as all structure below the generator floor level and not within the projected lines of the dam. So far no power plants with integral intakes built for a head of more than 100 ft have come to the writer's notice.

The principal elements of substructure cost are excavation, cofferdamming, concrete, and embedded metal gates and guides. Of these, concrete is the most important. Comparative concrete volumes for a number of power plant substructures are shown in Fig. 2(*a*). These generally follow the trend lines shown except for two plants where unusually large volumes of concrete were placed. In lower-head plants with integral intakes, recent practice has been increasingly away from mass "block" concrete construction toward more slender, fully reinforced structures, enclosing the hydraulic passages within reinforced concrete walls. Marmet and Safe Harbor are good examples of this type. Wilson has remained for 14 years the highest-head large plant employing a reinforced concrete scroll case, in spite of the apparent economy of this type for heads under 100 ft. A recent com-

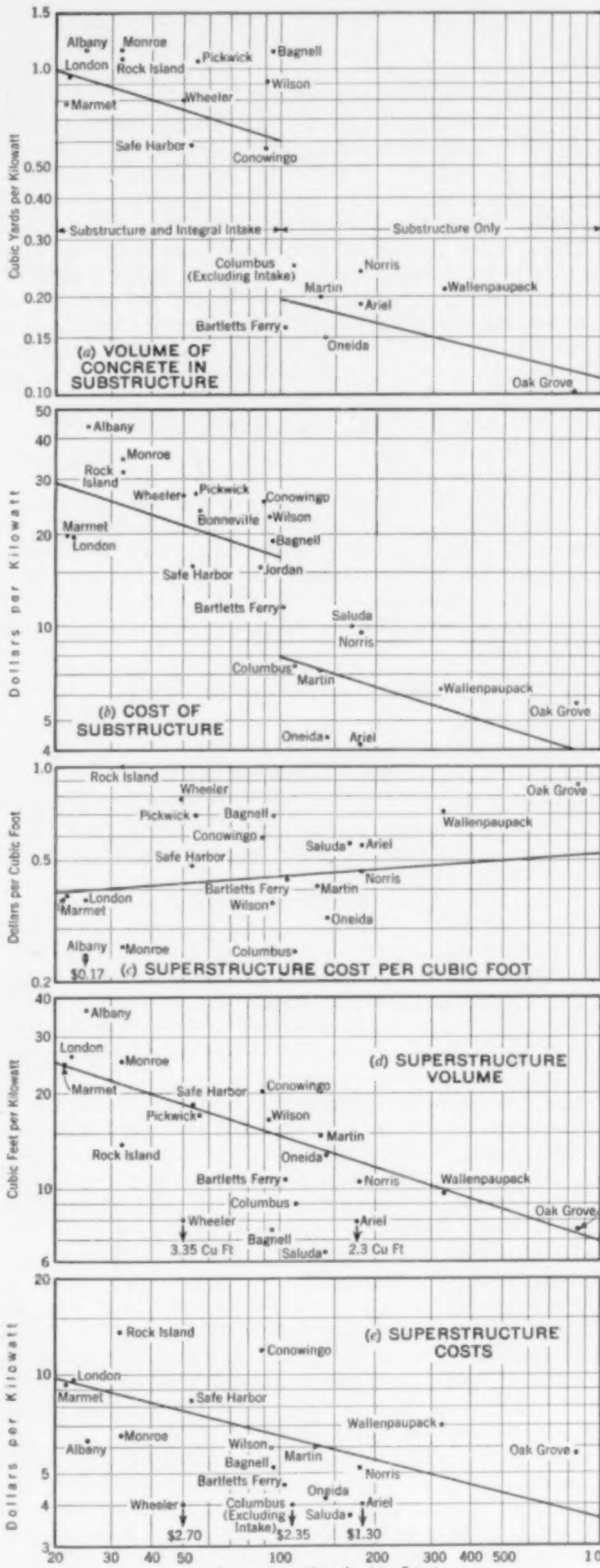


Fig. 2. Substructure and Superstructure Volumes and Costs

parative study shows the following costs for 1 sq ft of scroll-case hydraulic surface area:

Reinforced concrete:	
Form work (curved)......................	\$2.25
Reinforcing steel, 20 lb at 6 cents.........	1.20
Total..............	\$3.45
Plate steel:	
40 lb at 16 cents........................	\$6.40

In plants with heads of over 100 ft, mass concrete with embedded steel scroll-cases has been the practice for vertical turbines. Generally further latitude for economy is available to the future designer in arranging machinery to require the smallest practicable floor space.

Reinforced concrete substructures have so far not been very fully reinforced, modern examples showing only 50 to 90 lb of steel per cubic yard, and older structures even less. While no general change in practice over the last twenty years is noticeable, it is evident, both from the relatively low percentage of reinforcement used, and from the spread of the plotted points in Fig. 2(*a*), that the limit of economic design along present lines has by no means been reached.

Substructure costs per kilowatt are shown in Fig. 2(*b*), which shows the same general trend as the relative concrete volumes in Fig. 2(*a*). A few modern plants (Marmet, London, Safe Harbor, and Ariel) are noticeably lower in cost than the rest because of economic design, low unit construction cost, or both. Some unit construction costs for power plant substructures are shown in Table I.

SUPERSTRUCTURE COSTS VARY WIDELY

Account 321.5. Superstructure.—This subaccount includes all enclosed operating, bus-gallery, control-room, shop and office structures above the generator floor level. It covers not only the building structure but also the finish, trim, heating, lighting, plumbing, elevators, and any other strictly building accessories. Open-air transformer space is excluded.

In Fig. 2(*c*) is given the cost per cubic foot of contained space for 14 power-plant superstructures built during the last twenty years. The wide range of cost (from \$0.17 to \$1.00 per cu ft) is believed due largely to the choice of the designers of the various plants as to type of superstructure and amount and variety of finish, ornamentation, and equipment provided. Some of the superstructure frames carry roof switching stations.

The Albany power plant superstructure, costing \$0.17 per cu ft, is a very simple, although pleasing, one-story brick building with the operators' room housed in a gallery at one side. No office quarters, heating or ventilating equipment, or elevators were installed. The utmost economy was practiced, yet the result has been entirely satisfactory for this small plant. Martin and Safe Harbor power-plant superstructures are large buildings of considerable architectural beauty, provided with all the equipment of a modern office building. They cost \$0.40 and \$0.47 per cu ft, respectively, and reflect modern practice in large "indoor" power-plant superstructures. Other well-built "indoor" superstructures include Marmet, Wilson, and Bartlett's Ferry.

Ariel and Bagnell superstructures are of the "semi-outdoor" type, in which the building houses only the generating machinery, and the station crane is placed outdoors. Their high cost per cubic foot is partly accounted for by the relatively smaller buildings, with their greater proportion of higher-cost control space and service facilities. The superstructure cost of Wheeler, a plant of the wholly outdoor type, where the generator is

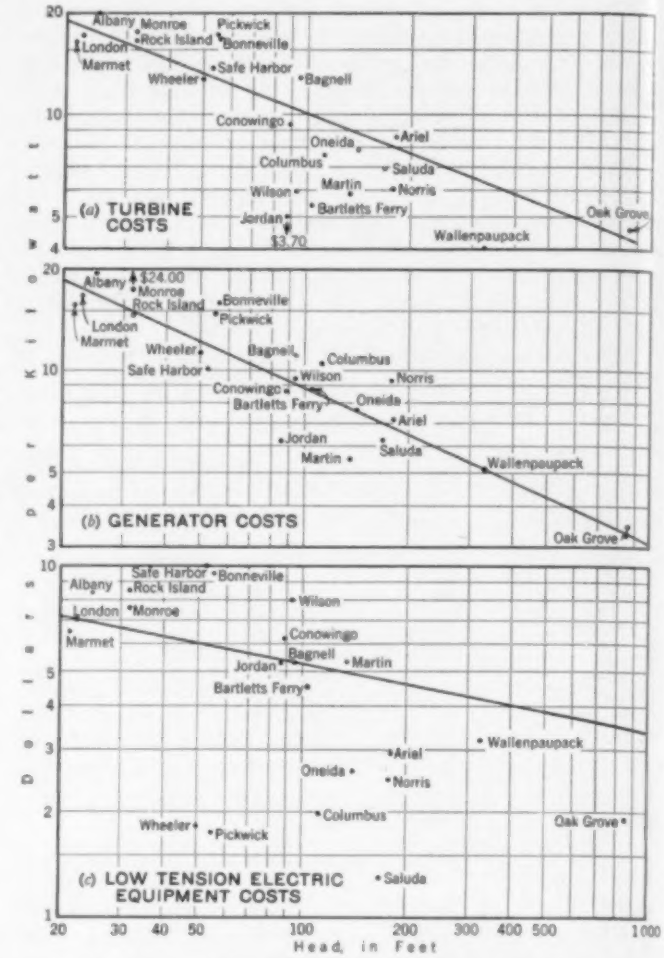


FIG. 3. COSTS OF TURBINES, GENERATORS, AND LOW-TENSION ELECTRICAL EQUIPMENT

housed only in a steel shell; Ariel, a semi-outdoor type; and Columbus, an indoor type, are far below the general average.

The last three parts of Fig. 2 form an interesting study of the relative size and cost of superstructures and should be considered together. The low unit cost per cubic foot of the Albany plant, Fig. 2(*c*), overcame the relatively large volume, Fig. 2(*d*), and produced the relatively low cost per installed kilowatt shown in Fig. 2(*e*), which summarizes the other figures and presents the relative cost efficiency in units of productive capacity. Ariel is outstanding in low cost per kilowatt, and appears to be the most efficient hydro power-plant superstructure, from the viewpoint of cost, yet built in this country.

Account 323.1. Turbines.—This group covers the cost, in place, of main power turbines, station service units, and their immediate auxiliaries—such as governors, oil pumps, and pressure tanks. Turbine costs exhibit a fairly uniform general trend with head, although there are marked individual variations. All the plants shown in Fig. 3(*a*) below 80-ft head, except Albany, have propeller turbines. Albany and Wilson have Francis turbines in concrete scroll-cases, while the remaining group between 80 and 200-ft heads have Francis wheels in plate-steel scrolls. No definite trend of cost with time is noticeable, although some of the more recent jobs are among the more costly.

The limit of economy with increase in size of individual units has apparently been reached in some of the recent low-head plants with runner diameters approximating 24 ft. Savings may still be made through changes in

design, such as the substitution of welded speed-rings, head covers, and so forth, for cast parts. Use of concrete scroll-cases for plants just under 100-ft head, and higher rotative speeds at lower heads through better runner, scroll-case, and draft-tube design, offer other possibilities.

Turbine efficiencies of 90 per cent or more offer little opportunity for gain in capacity. However, more refined hydraulic designs may permit increased draft heads, with savings in structure and excavation, in addition to increasing the operating period between cavitation welding. Welded, stress-annealed, plate-steel scroll-cases are also in the offing.

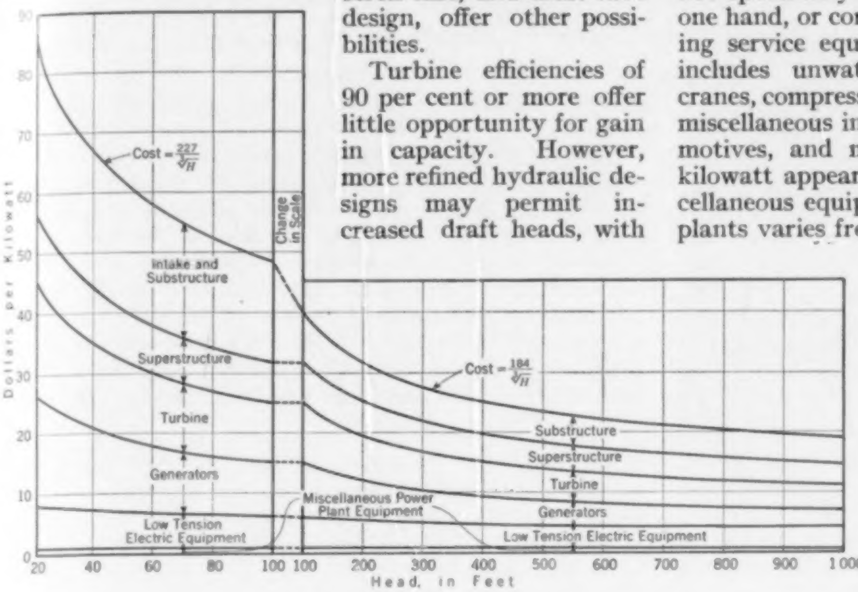


Fig. 4. Elements of Power Plant Costs

Account 323.2. Generators.—This group covers the cost, in place, of main power generators, station service units, exciters, ventilation and cooling systems, and other direct auxiliaries. For equitable comparison, most generator ratings in this study have been stated at 90-per cent power factor. Plotted against head, as in Fig. 3(*b*), costs per kilowatt show marked adherence to a systematic trend, as is to be expected. The dispersion is due both to variation in choice of speed for the same head and power, and to changes in relative cost levels.

Generators will share in any future economies arising out of higher turbine speeds. Welded-steel rotors and frames have recently been built, and higher operating temperatures are being permitted, both tending toward lower cost. Individual ventilation and cooling have become standard features adding to cost.

Account 324. Low-Tension Electric Equipment.—This account covers the cost of low-tension bus, cell structure (except power plant concrete), circuit breakers, station service connections, and all instrument control wiring, switchboards, and other control equipment. These costs, varying generally from $3.00 to $7.00 per kilowatt, with some important exceptions, are shown in Fig. 3(*c*). The great variety of layouts in different plants is remarkable, no one type of design having so far prevailed to any great extent. Several large power plants devote so much space to low-tension bus and control equipment as to materially increase substructure cost. Low-tension buses are still in vogue; sometimes even a partial double bus is used. On the other hand, some plants have achieved notably lower costs with direct generator-to-transformer connections, eliminating low-tension buses and circuit breakers altogether. It appears that with transmission systems interconnected between several power sources, much complication in low-tension wiring to secure flexibility is ordinarily no longer justified, and that the economies of simplicity may be realized to a larger extent.

Account 325. Miscellaneous Power Plant Equipment.—This account includes all general power-plant equipment not specifically auxiliary to any major machine on the one hand, or coming specifically under the head of building service equipment on the other. For example, it includes unwatering and drainage systems, station cranes, compressors, filters, machine-shop and other tools, miscellaneous instruments, fire-fighting equipment, locomotives, and motorboats. About $1.00 per installed kilowatt appears to be the general expenditure for miscellaneous equipment, though the amount at individual plants varies from as little as $0.10 to as much as $3.30 per kw. (The plot of these costs is omitted to conserve space.) Large installations in machine shops and heavy tools appear to be diminishing, as they are seldom used, although provision for general-purpose instruments such as water-storage and flow recorders is deservedly increasing.

The average cost of the six elements of the hydro power plant are set forth in Fig. 4, where the curves for individual trends have been summed up. The relative importance of each through the entire range of head may be visualized from this diagram.

Turbines and generators are manufactured products and their cost is a matter for discussion with the makers. The structural elements of the plant are more directly under the control of the designer and constructor, and important economies in them can still be effected by advance study of the general design, by eliminating superfluous structure, and by adapting the design to rapid, simple construction. Important economies also appear to be possible in the layout and selection of low-tension electric equipment.

A study has been made to show the relative efficiency in unit spacing for power plants of varying sizes and heads. To make possible a comparison of plants of different sizes, the square root of the kilowatt output has been taken as the appropriate unit to express comparable turbine spacing. The square root of capacity divided by the unit spacing has been plotted against head, to show the general trend, in Fig. 5. Most plants are remarkably close to the general-trend line, but several show space utilization much better than the general trend. No general superiority of the larger-unit plants in this regard, other than their natural greater capacity per lineal foot of power plant (in the ratio of diameter-squared), is noticeable, and no general time-trend toward greater space utilization is apparent, although a few recent plants are considerably better than the average.

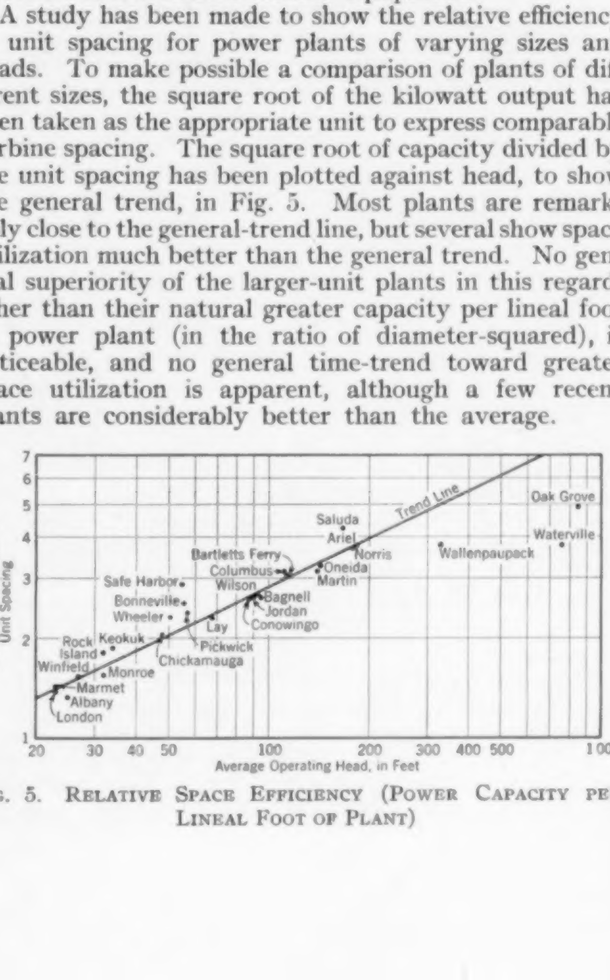


Fig. 5. Relative Space Efficiency (Power Capacity per Lineal Foot of Plant)

Autobiography of George H. Pegram—Part I

Childhood—"Life on the Mississippi"—Frontier Experiences—First Engineering Work

By THE LATE GEORGE H. PEGRAM, PAST-PRESIDENT AND HON. M. AM. SOC. C.E.

OUTSTANDING among twentieth century American engineers was the late George H. Pegram, for many years chief engineer of the Interborough Rapid Transit Company in New York City. Mr. Pegram was a member of the Society for fifty-seven years and served it in many capacities—as Director from 1902 to 1904, Vice-President in 1909 and 1910, and President in 1917. He was elected an Honorary Member in 1931. It may be said that Mr. Pegram's life symbolizes the past half century of American engineering history, spanning as it does the developments of a pioneer civilization and the modern miracle of subway construction in New York City.

Some years before his death, which occurred on December 23, 1937, Mr. Pegram yielded to the urging of his daughters and prepared an informal autobiography. Now, through the courtesy of his family, this manuscript has been made available to "Civil Engineering" and will be presented in abridged form in a number of installments. The first of these covers Mr. Pegram's life from his early days in the frontier town of Council Bluffs to the time when—at the age of twenty-five—he came East for his first important engineering job.

I WAS born December 29, 1855, in Council Bluffs, Iowa, so named from the council between Lewis and Clark and the Indians in 1804. The town is located about three miles from the Missouri River at the foot of the yellow clay bluffs. Between the bluffs and the river are the level bottom lands—clothed in memory with a perpetual carpet of sunflowers. A stream, in my time graced with the name of the "Lousy" but now called Indian Creek, rises in the hills and flows across the bottoms to the river.

From 1846 to 1849 the town was occupied by the Mormons and called Kanesville, which historic fact doubtless accounts for my having had as nurse, Amelia Fulsom, afterwards the favorite wife of Brigham Young. I met this estimable woman after she had become the Queen of Utah and was proud of my choice of such a sensible person for nurse.

About the time the Mormons left for Utah, gold was found in California, and soon afterwards in Colorado, and Council Bluffs became the outfitting point for expeditions of emigrants. This attracted business men as well as prospectors and promoters—a community of wise and courageous men as I have always found a frontier town to be. My father had a bank and a store and was also engaged in freighting across the plains to Denver.

It was an Indian country, the headquarters of the Pottawatomies. Although I was scarcely six years old when we left Council Bluffs, I recall many things about them. An Indian, possibly a great chief, would call with a few followers, at the kitchen door for food. Often a handout was given; if not, they were told "pocochee," which meant "go away." Then they would stand unabashed by the living-room windows and see what was going on inside. They were naturally honest, and my father often allowed them to sleep in the store without a thought that they would take anything.

I was born in a log cabin, one of the palaces of the town, most of the houses being slab or board with canvas roofs. At the time of our departure, however, there was a two-story brick block, shown in the photograph.

MOVING A PIONEER FAMILY

My father decided to move to St. Louis to join his brother in steamboating on the Mississippi. We started on a 150-mile trip to the nearest railroad—at St. Joseph, Mo.—on a cold December night with the country covered with snow. The stage was a bob-sled—a wagon-bed mounted on two pairs of runners. Mattresses were put in the bottom of the wagon-bed, which was covered with the regulation canvas top, and thus we slept and rode until morning, when we changed to a sleigh with seats. About noon of the day we left St. Joseph, or "St. Joe" as it was commonly called, the train became derailed. This was a common experience with the old style of track, where the rails had no connection with each other except the seat in a cast-iron chair through which they were spiked to the wooden ties.

STEAMBOATING ON THE MISSISSIPPI

My father became associated with my uncle in steamboating on the Mississippi and for years commanded a boat in the Southern trade. His first boat was the *Ruth*, which burned while transporting government supplies, within six months after she was built, and such was the profitable nature of the business that she had earned more than her cost. A boat, also named *Ruth*, was immediately built to replace her. She was the finest and fastest boat on the Mississippi and "carried the broom" stuck out over the forward deck as a symbol. Her time from New Orleans to St. Louis (1,250 miles) was 4 days, 9 hours, 54 minutes, which was not beaten until the great *Natchez* and *Lee* race. She burned after the war, all the family except me being on her at the time.

The building of the *Ruth* was followed in rapid order by the building or purchase of a number of other boats, so that near the close of the war the Pegrams owned quite a fleet which, together with most other boats on the Mississippi, was formed into the Atlantic and Mississippi Steamship Company. My uncle was vice-president of the company, and my father agent at New Orleans.

As New Orleans had no rail connections with the outside world, the river front was naturally a very busy place. Ships would arrive from Europe with rails and other merchandise for transshipment to interior points, and receive in return foodstuffs for foreign destinations. Steamboats from the Mississippi and its numerous tributaries were arriving and departing at frequent intervals. But all this has changed. As a measure of the decline of river traffic under railroad competition, there is now [1929] not a boat on the Mississippi with a capacity one-quarter that of my father's last boat, the *James Howard* (a model of which is in the Smithsonian Institution), which could carry 4,000 tons of freight.

Socially, New Orleans was gay. Originally a French city, it has preserved French customs. Early in the morning my father and mother would drive in the buggy to the

French market, as was the custom, take a cup of coffee and chat with friends. They would then order their supplies for the day and return home for breakfast. New Orleans at that time had the only permanent opera in America. We had a box at the opera and the best theater and, even at the age of ten, I became familiar with such amusements.

In 1866, when I was nearly eleven years old, we returned to St. Louis. In the fall of that year my mother took me to Washington University, which had been founded by a group of Unitarians including my uncle, who saw the need of facilities for educating their children at home. It included grade school as well as advanced and college work. Each of the classes was supposed to take a year. However, it took me two years to get through the lowest class. At first, I could not learn. I would read my lessons aloud at home until the servants could repeat them from memory, but not I! Finally, though, I began to learn. I presume my mind had been jogged into action—and I had also acquired the habit of work, which is the foundation of all accomplishment. At seventeen, I entered the Polytechnic School, due to taking two classes a year on occasion. I could not have done this without the help of Professor Stone, principal of the academy, a great man and my great friend.

During this period my father's business continued to be steamboating, and I enjoyed myself greatly on occasional trips. One of the historic characters on one of the boats was Andy Fleming, a man densely ignorant—except in the science of piloting, in which he was supreme. The captain once asked him if wood could be obtained in Milliken's Bend. Fleming said it could. "Is it accessible?" he was asked. "No, I think it's ash."

Fleming's chief claim to fame is in having given the name of Mark Twain to Samuel Clemens. They were partner pilots, and Clemens had written a skit about Fleming while sitting on the bench in the back of the pilot house. "How shall I sign it?" he asked his neighbor. Just then the man at the front who was passing the word while soundings were being taken called "mark twain" (two fathoms), and he signed it "Mark Twain."

WE CARRY DISTINGUISHED GUESTS

When the Duke Alexis of Russia visited this country in 1871, my father's boat, the *James Howard*, was chartered exclusively to take the Duke's party down the Mississippi from Memphis to New Orleans. Our family accompanied my father on this trip. The *Great Republic* had orginally secured the contract for this trip, my father not being interested, as he preferred to attend to his regular business plying between Memphis and New Orleans. The *Grand Republic* was transformed into a floating palace and, with a picked crew, was proceeding down the river to meet the ducal party at Memphis when the weather turned very cold and the boat was frozen in the ice with no hope of a timely release. The *James Howard*, the largest on the river, chanced to arrive at Memphis a few days before the ducal party was expected. My father was appealed to and agreed to land the party at New Orleans at 10 o'clock on a Wednesday morning for ten thousand dollars, no passengers or freight to be taken. So the *James Howard*, comfortable but undecorated, left with the party on Saturday.

The party numbered twenty-two, exclusive of numerous servants. There were several distinguished guests, the principal in my eyes being General Custer, who wore a broad-brimmed hat. The Duke's party had just returned from a trip on the prairie with him. Shortly after the trip down the river he was killed in the fight with Sitting Bull's tribe. Admiral Poisset, the head of the party, wished to study the river conditions, and numerous conversations with my father served to make them friends. On one occasion the boat was run aground to illustrate the method of getting her off but, as the river was falling, it proved a very exhausting process.

Street Scene in Council Bluffs, Iowa, About 1860
The Prairie Schooner Is Drawn by a Typical Mormon Team—Three Yoke of Oxen and One of Cows; Pegram Store at Right

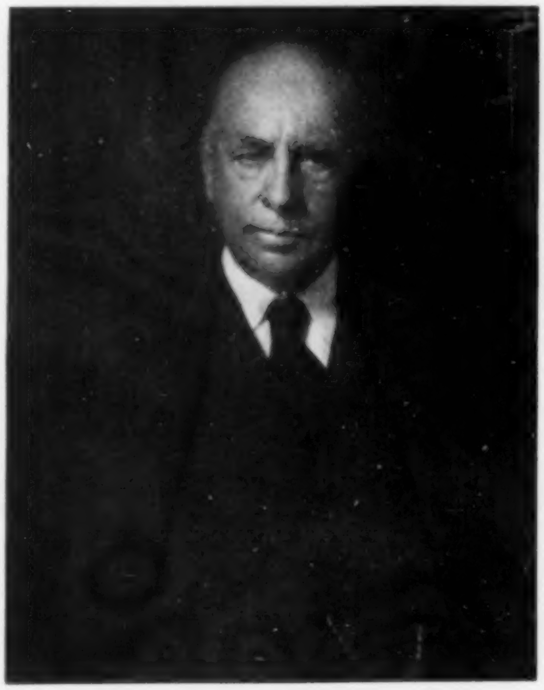
We reached New Orleans Tuesday, but as we were not expected until ten o'clock the next morning, stopped over night at Carrolton, a few miles above the city, and our entrance to New Orleans was a never-to-be-forgotten experience. With cannons booming, bands playing, and ships dressed, we moved slowly along the Crescent and arrived exactly on time. Before landing, the Duke sent for my father and, with a gracious speech saying they had received so much more than their passage, presented him with a ring set with a large emerald surrounded by sixteen diamonds.

My college course corresponded with the usual routine, except that our college was small and we received more intensive cultivation by the faculty. C. M. Woodward, the dean of the polytechnic department and author of the monumental work, *The St. Louis Bridge*, was a really great man. His manner of teaching was unique. After a problem was put on the blackboard, he would take a seat with the class and try to view it as they did, sometimes making a suggestion that would lead to a blind alley, and then saying, "Well, what can we do now?" With occasional hints we would finally dig it out.

Years after, when I was in charge of the construction of the Battery Tunnel in New York, I took him down into the tunnel and called his attention to a 2-in. plank with a span of 4 ft that was sustaining the lateral pressure of a depth of sand 90 ft below the street without deflection. Pointing to it I said, "That shows what bunk all that stuff you taught me about conjugate pressures was. According to theory, a much thicker plank would not only have bent but broken." He only smiled and remarked, "Give it time."

I graduated in 1877. At the exercises Dr. Eliot, the chancellor, remarked that I had sustained the highest standard of any graduate up to that time. So much for hard work! In the fall I started to find a job, but 1877 was one of several depression years and work was scarce. Finally, with the assistance of General Dodge, a director of the Union Pacific, I was made one of a surveying party for an extension of the Utah and Northern, from Franklin, Idaho, north to the bluffs bordering Bear

River. The Nez Percés Indian War was raging in this region at the time, but the party went armed and the route was under the protection of soldiers. Our routine was regular. We lived two to a tent, sleeping on the ground, which was not only very hard, but so cold that we needed more blankets under than over us which, considering the cold nights in the mountains, is saying a good deal.



THE LATE GEORGE H. PEGRAM
This Photograph Was Taken in 1936

This work lasted from September to Christmas, when the party was disbanded and I went home to St. Louis. The only thing I can take credit for on this project was the location of the track down the bluff to the Bear River Valley, which the directors, in their initial trip of inspection of the finished line a year later, praised as fitting the ground more perfectly than any they had seen. This is how the "perfect fit" was accomplished. One very cold day I was running the line on the top of the finished embankment to set the center stakes for the track. If I followed the original location notes, the line ran off the embankment, and I discovered that the contractor for the grading had used the line of stakes which defined the bottom of the slope for the center of the embankment. I had an old sailor, who was a member of the party, driving the stakes. He had to chop holes in the frozen ground to set the stakes and had difficulty in making them stay set. When it was necessary to reset one for accuracy, his patience was exhausted. I finally said to him, "This is all humbug. Let's put the stakes in the middle of the bank and let it go at that." Thus the beautiful mule-shoe curve, which the line of slope stakes happened to form and which so beautifully fitted the topography, was created!

Early in March I was offered and accepted the position of assistant to Col. C. Shaler Smith, noted bridge engineer. This was obtained through the kind offices of Prof. Charles A. Smith, head of the civil engineering department at Washington University.

Colonel Smith had a fine personality, and association with him in the formative period of my life has had an important effect upon my character. He was consulting engineer on the St. Louis Bridge, and we had an office which opened directly on the western approach of the bridge. He was also consulting engineer for the Chicago, Milwaukee, St. Paul Railroad and the Atchison, Topeka and Santa Fe Railway, designing all their bridges.

At this time the latter railroad was extending its line from Pueblo to the west through the Arkansas River Canyon, at the Royal Gorge of which it was necessary to build a bridge lengthwise of the river to carry the railroad through the gorge. The river at this point flowed between precipitous walls 3,000 ft high, with a width between of only 70 ft for the river. I was sent by Colonel Smith to examine the site.

While in Canyon City I encountered the stream of travel to Leadville, where discoveries of silver had started a boom, and I caught the mining fever. Returning to St. Louis, I completed the calculations and drawings of the Royal Gorge Bridge, using Colonel Smith's novel design of hanging plate girders from arch braces abutting on the rock at the sides of the canyon to carry the side of the track, the other side being supported by the rock.

I resigned March 1, 1879, and went to Leadville with a friend about my own age. We opened the Elephant Store, where we sold goods wholesale and retail to prospectors, taking an interest in some of the prospects in return for the "grubstake."

I found Leadville, located at an elevation only 100 ft below the timber line, an exceedingly interesting and colorful place to live. My father visited me on one occasion. I promised his favorite play *Macbeth*. The theater was a long one-story frame building, with a bar at the street end. There were card tables in front of the bar and wooden benches facing the stage at the rear end. Two features of the establishment were interesting. The globes on the chandeliers were a source of income as one had to pay highly for breaking them—a discouragement to promiscuous shooting—and the counter of the bar was packed with sandbags as a refuge for the bar-keepers in times of stress.

Late in August I left Leadville for St. Louis to resume work with Colonel Smith. At that time we were working on plans for the Minnehaha Bridge across the Mississippi near Minneapolis, subsequently built for the Chicago, Milwaukee, and St. Paul Railway.

NO REST FOR THE ENGINEER

One Sunday morning about two months after my return, we were luxuriating in the fact that it was the first Sunday we would not have to work. At breakfast we opened the paper and read of the fall of a span of the bridge across the Missouri at St. Charles, which cut the Wabash Railroad in two. This was a bridge that Colonel Smith had designed. We went immediately to St. Charles, and Colonel Smith was given the work of removing the wreck and replacing the span. This necessitated my residing on the wreckage of cattle cars and twisted iron in the river, which unfortunately was rising, making smaller and smaller the island of wreckage on which we were working. The bridge had cast-iron top chords and end posts in keeping with the universal practice of the period in which it was built. The 315-ft through span which fell had a floor of 16-in. wooden beams supported on I-beams in the bottom chords. Apparently the train had become derailed, broken the floor beams, and bent down the bottom bracing, thus drawing in the bottom chords and bending the top chords outward, breaking the castings. By then cast iron was no longer used in bridges, and the catastrophe emphasized the wisdom of the change in practice.

Colonel Smith was consulting engineer of the Edgmoor Iron Company of Wilmington, Del. In the spring of 1880 the chief engineer of the company had resigned, and Colonel Smith was asked to supply an engineer until they could fill the position. I was sent in May of that year—and remained until May 1, 1886.

More Water for Utah's Cities and Farms

Deer Creek Division of the Provo River Project Now Under Way

By E. A. Jacob, M. Am. Soc. C.E.
and E. O. Larson
Respectively City Engineer of Provo, Utah, and Engineer, U. S. Bureau of Reclamation, Salt Lake City, Utah

Half the population of Utah will ultimately be served in whole or in part by the Provo River Project, the Deer Creek Division of which is now under construction. A transmountain diversion, a large storage reservoir, canal enlargements, and a 42-mile aqueduct are its outstanding features. The project is unusually complicated, both because of the number and variety of interests involved, and because of the necessity of satisfying prior rights while at the same time utilizing every drop of water to the fullest extent. The accompanying article comprises both a general review of the project and a detailed description of Deer Creek Dam. It is an up-to-date and condensed version of the papers presented by Messrs. Jacob and Larson before the Irrigation Division at the 1938 Annual Convention in Salt Lake City, Utah.

Utah has a total area of 54,400,000 acres, only 1,300,000, or 2.4 per cent, of which are irrigated. Large areas of fertile and tillable land await only irrigation to make them productive. The state's argicultural development is therefore limited by the available water supply for domestic and irrigation uses.

Of prime importance, then, is the complex project for water utilization that is now under way in the region south and east of Salt Lake City. Known as the Deer Creek Division of the Provo River Project, it comprises the following features (Fig. 1):

1. An earth dam 155 ft high and 1,400 ft long at the crest, located on the Provo River about 17 miles northeast of Provo. Construction of this dam involves the relocation of about 10 miles of the Heber Branch of the Denver and Rio Grande Western Railroad, and about 9 miles of highway.
2. The Weber-Provo Diversion Canal enlargement to divert water from the Weber River to the Provo River. The present canal has a capacity of 210 cu ft per sec and will be enlarged to a 1,000 cu ft per sec capacity. Its existing diversion works were originally built for 1,000 cu ft per sec capacity, and a number of existing small structures along the canal can still be used by making minor extensions. A right of way for the larger canal has been provided throughout the entire length of 8 miles.
3. The 5.5-mile Duchesne Tunnel, to divert waters from the Colorado River watershed to the Provo River.
4. Enlargement of the Provo Reservoir Canal, extending from Provo River to Jordan Narrows with a capacity of 550 cu ft per sec at the intake on Provo River. There will be included in this construction the Jordan River inverted siphon and pumping plant used to lift water from the Jordan River into the Utah Lake Distributing Canal.
5. The Salt Lake City Aqueduct, extending from the dam in Provo Canyon to Salt Lake City—a distance of approximately 42 miles. The project is estimated to cost $7,600,000, exclusive of the Salt Lake Aqueduct. The latter will cost approximately $5,500,000.

Possible storage developments on the Provo River have been investigated from time to time for a long period of years. The Bureau of Reclamation, in cooperation with the state of Utah through the Water Storage Commission, first studied the water situation on the river in 1923, and since that time has investigated about 12 dam sites at various locations from the mouth of Provo Canyon upstream for a distance of more than 30 miles. Through an extensive testing program of diamond drilling and open test-pit work, most of the sites were finally eliminated, and what is known as the Deer Creek site was finally determined to be the most feasible from the standpoint of cost, desired reservoir capacity, and location with respect to future storage reservoirs.

Extensive investigations have also been carried on as to the location of the Weber-Provo Diversion Canal, the Duchesne Tunnel, and the Provo Reservoir Canal enlargement, all with the idea of correlating these features most efficiently with the Deer Creek Reservoir and future developments on the Provo and Weber river

Site of Deer Creek Dam in Late Summer, 1938
Highway Excavation and Stripping Is Under Way on the Left Abutment (Background); Stripping of Part of Dam Foundation Has Been Completed

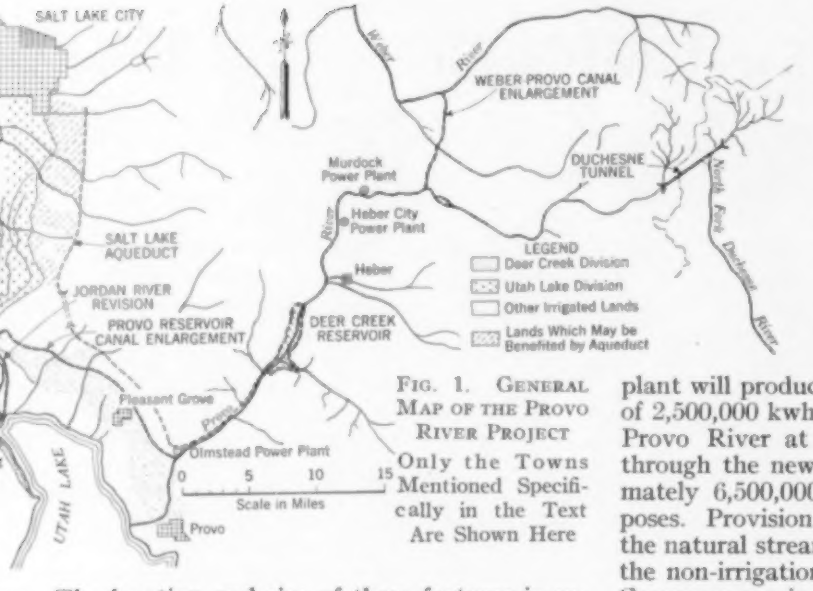


FIG. 1. GENERAL MAP OF THE PROVO RIVER PROJECT
Only the Towns Mentioned Specifically in the Text Are Shown Here

Light Company through plants on the Provo River. In order to make concurrent power replacements, it will be necessary to construct a power plant at Deer Creek Dam as a part of the project works.

Winter water from the Weber River diverted through the Weber-Provo Diversion Canal, and winter water diverted through the Duchesne Tunnel, will flow down the Provo River and be carried through the Murdock plant of the Power Company, which is located about 8 miles above Heber City. This plant will produce an annual average power replacement of 2,500,000 kwhr. In addition, the natural flow of the Provo River at the Deer Creek Dam will be carried through the new power plant and will furnish approximately 6,500,000 kwhr each year for replacement purposes. Provision is made in the agreement for fluctuating the natural stream flow at the Deer Creek Dam during the non-irrigation season, in such a way that the Power Company can increase the delivery of water to its Olmstead plant during the time of peak load each day.

Provision is also made for withholding water from Utah Lake in certain periods during the winter season and making replacements for water thus retained during the high-water period of the following year.

The water supply from the Duchesne River averages 33,000 acre-ft a year. This supply will be diverted through the Duchesne Tunnel to the Provo River. The maximum flow will be 325 cu ft per sec (the tunnel capacity) and the minimum flow, occurring in winter, will be about 10

systems. The location and size of these features is extremely important as all will be more fully utilized when additional reservoirs are constructed on the Provo and Weber rivers, and when possibly a second tunnel is built into the Colorado River watershed for diverting of additional water from the Uinta Mountains at the head of Duchesne River—one of the best watersheds in the state.

Water for the Deer Creek Reservoir will come from four sources—Duchesne River, Weber River, Provo River, and the return seepage flow from the use of project waters for irrigation.

The Weber River will furnish a yearly average of approximately 54,000 acre-ft of water from flood flow and 23,000 acre-ft of winter "power water." The winter water on Weber River has heretofore been used to furnish power at the Weber and Riverdale hydroelectric plants under rights owned by the Utah Power and Light Company.

An agreement has recently been worked out between the power company, the U. S. Bureau of Reclamation, and the Provo River and Weber River water users associations, which provides for an equal division of winter power water between the Weber and Provo associations. The loss of power at the Weber and Riverdale plants, averaging about 9,000,000 kwhr per year, will be replaced concurrently to the Utah Power and

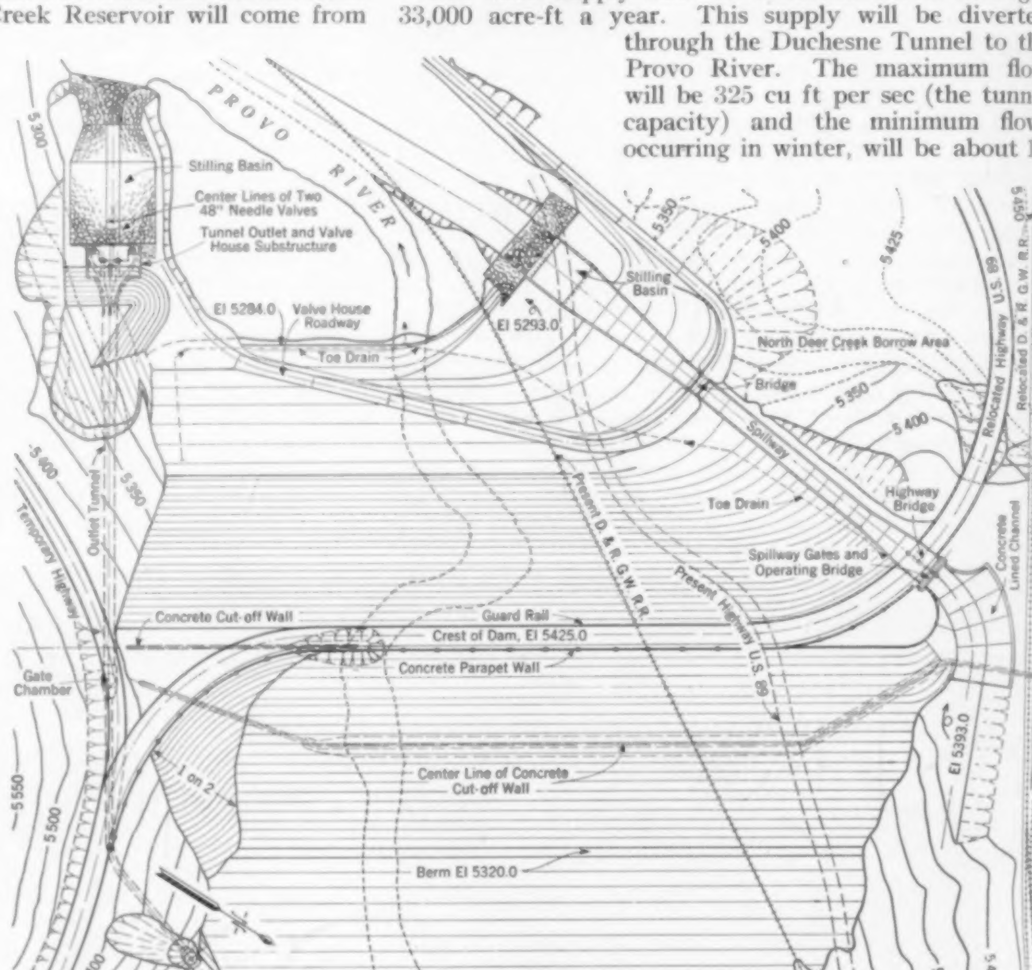


FIG. 2. GENERAL PLAN OF DEER CREEK DAM

cu ft per sec. The water supply records of the Duchesne River show a maximum diversion possibility of 53,000 acre-ft in 1917 and a minimum of 16,000 acre-ft in 1934.

Provo River will supply surplus water for storage in the Deer Creek Reservoir during those years when Utah Lake is at or near "Compromise level," and when there is a surplus of water in the Provo River above the quantity decreed to present water users. "Compromise level" is the level above which no water may be stored in Utah Lake by artificial barrier at the Jordan River outlet, agreed to between owners of water rights in Utah Lake and owners of low agricultural lands lying near the lake. There is a possibility that in certain dry years, water to which the Utah Lake interests are entitled may be retained in the Deer Creek Reservoir, diverted through the project canal from the mouth of Provo Canyon to the Jordan Narrows, and delivered in the Jordan River at the Narrows in the late part of the irrigation season, for the use of the Associated Canal Companies in Salt Lake Valley. Thus a certain quantity of water may be conserved to the project by eliminating evaporation from the surface of Utah Lake that occurs under present conditions. This saving has not been taken into account as a potential supply, but it is a factor that should receive consideration as an operative feature of the project.

SEEPAGE RETURN FLOW MUST BE TAKEN INTO ACCOUNT

The engineers of the Bureau of Reclamation are now studying the flow of the Provo River at several points along its course. Included in these studies are studies of seepage return flow from normal irrigation in the vicinity, and particularly seepage and return flow to the river in the reservoir area.

Most of the Class A water rights used in Utah Valley below the mouth of Provo Canyon (extending from Provo northerly to Pleasant Grove) are at present supplied from seepage return flow to the river above the Deer Creek Dam. This water must, at all times during the operation of the reservoir, be carefully measured so that there shall be no encroachment upon the prior water rights below the reservoir. This involves complicated studies of river inflow at the upper end of the reservoir, outflow at the dam, evaporation on the reservoir surface, change of content in the reservoir, and bank storage around the reservoir area. It is expected that three or four years of study before any storage is made in the reservoir will give sufficient foundation data to aid in making the necessary calculations during the subsequent operation of the reservoir waters.

The reservoir will be constructed with a live storage capacity of 147,000 acre-ft, 3,000 acre-ft being retained for fish culture and power head. The annual yield that will be sold to subscribers is 100,000 acre-ft, 58,000 acre-ft going to municipalities and 42,000 acre-ft to irrigation. Already 93,000 acre-ft have been subscribed.

Water supply studies on the three rivers show that the project would have had 100 per cent of its yield in each year since 1910 except 1926, 1931, and 1934. In these extremely dry years, the supply available for use would have ranged from 65 to 80 per cent of the yield.

The subscribing units include six cities organized as metropolitan water districts, two conservation districts, and six irrigation companies. The larger cities under the project—Salt Lake City and Provo—are growing rapidly and need an adequate future water supply to provide for increasing population and industrial development.

About 40,000 acres of land will be furnished a supplemental water supply for irrigation, making possible greatly increased crop production in normal years; and in years of extreme drought, the area will be protected against the complete loss of crops, including fruit trees and alfalfa. The population served by the project exceeds 225,000, or nearly half the population of the state.

Inclusion of the Salt Lake City aqueduct as a unit of the project is of vital importance to Salt Lake City, the other metropolitan water districts north of Provo, and the suburban area south of Salt Lake City. This suburban area can be irrigated from the aqueduct until such time as it becomes a part of the city, when the water will be used for municipal purposes.

Auxiliary to the subscription contracts entered into between the United States and the Provo River Water Users Association are several other contracts, as follows: With the Denver and Rio Grande Western Railroad Company for the relocation of the railroad around the reservoir; with the State Road Commission for relocation of the highway; with the Utah Power and Light Company and the Weber River Water Users Association for the diversion of the Weber River winter water; with the Weber River Water Users Association for enlargement of the Weber-Provo Diversion Canal; with the Provo Reservoir Company for the enlargement of its canal and transfer to rights of way from the Provo River to Jordan Narrows; with the Associated Canals of Salt Lake County for right of way for project waters through their pumping plant on Utah Lake and through Jordan River. Agreements have been reached on most of these contracts and some have been executed. The United States will be a party to all of them.

DEER CREEK DAM NOW UNDER CONSTRUCTION

Construction of the Deer Creek Dam and appurtenant works was begun in May 1938. As shown in Figs. 2 and 3, the main structure will consist of a compacted embankment of selected materials, protected on the upper part of the upstream slope by a layer of rock riprap and backed on the downstream slope by a rock fill in-

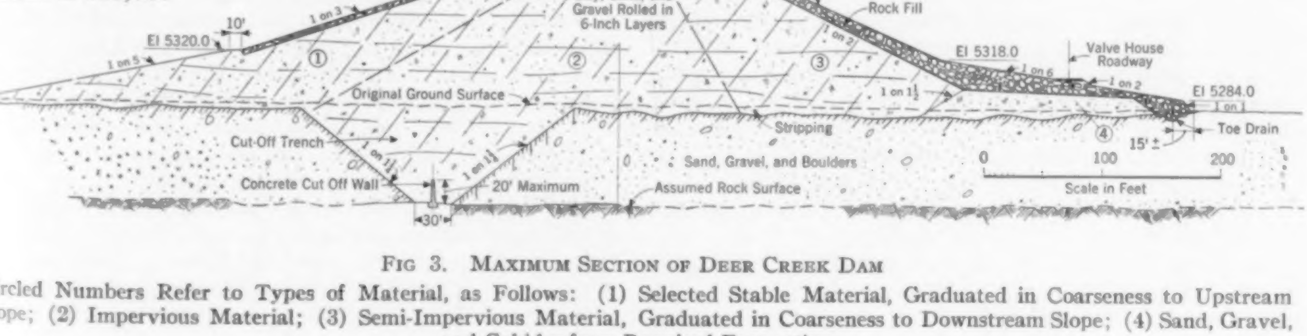


Fig 3. Maximum Section of Deer Creek Dam

Circled Numbers Refer to Types of Material, as Follows: (1) Selected Stable Material, Graduated in Coarseness to Upstream Slope; (2) Impervious Material; (3) Semi-Impervious Material, Graduated in Coarseness to Downstream Slope; (4) Sand, Gravel, and Cobbles from Required Excavation

LOOKING UPSTREAM INTO THE FUTURE DEER CREEK RESERVOIR, FROM JUST ABOVE THE DAM SITE
Note the Horseshoe Tunnel Form in Left Foreground and Rock from Highway Excavation Stockpiled in Right Background

creasing in thickness from the crest to the toe of the embankment. The estimated quantities are 2,700,000 cu yd of embankment, 41,000 cu yd of riprap, and 182,000 cu yd of rock fill.

When completed, the dam will rise 155 ft above the stream bed and extend approximately 1,400 ft between canyon walls at the crest. It will exceed 1,000 ft in maximum thickness at the base, diminishing to 35 ft at roadway level.

Exploration of the foundation has disclosed a heavy overburden of sand, gravel, and boulders, having a maximum depth of 85 ft, overlying the limestone bedrock. A reinforced concrete cut-off wall with a maximum height of 20 ft will extend across the canyon a short distance upstream from the axis of the dam. It will be bonded to the bedrock, which will be exposed by excavating a trench with a bottom width of 30 ft.

A reinforced concrete spillway 953 ft long and capable of discharging 12,000 cu ft per sec, will be constructed at the right abutment of the dam. Discharge through it will be regulated by two radial gates, each 21 ft long and 20 ft high, which when lowered will permit the water surface to rise 20 ft above the spillway crest, to the normal maximum water surface of the reservoir.

PROVISIONS FOR DIVERSION

Provisions for by-passing the natural flow of the river during construction operations are being made by constructing a tunnel through the left abutment of the dam. This tunnel will later serve as an outlet works and control for reservoir releases. By means of a temporary diversion opening in the inlet structure, water will enter the concrete-lined bore and be conveyed in turn through the tunnel, through a concrete flume, and beyond to the stilling basin downstream from the construction operations.

The upstream 447 ft of the tunnel—that is, the section from the inlet to the gate chamber—will be 12 ft in diameter and is designed to operate under pressure. Downstream from the gates for approximately 400 ft, the tunnel will be an 11-ft 6-in. by 17-ft horseshoe section, and between the outlet portal and the valve house substructure, a distance of 227 ft, water will be by-passed through a concrete flume having the same cross-section as the bottom part of the horseshoe tunnel.

A 4-ft by 5-ft rectangular conduit will be built under the tunnel invert to carry the stream during a period of low flow when the time comes to install the outlet pipes and emergency gates. The outlet pipes will be of welded steel construction, 72 in. in diameter, and will be carried on concrete supports through the horseshoe section of the tunnel and encased in concrete in the flume. The lower ends of these pipes will be bulkheaded until such time as they will be used for power penstocks. Two 57-in. pipes, branching from the 72-in. outlet pipes and terminating in needle valves, will be provided for regulating the flow from the reservoir. Provisions for future power development will be made by constructing a valve house substructure which will ultimately serve as a foundation for a power house, in which generating equipment will be installed as needed.

REDUCING THE GAMBLE FOR PROSPECTIVE BIDDERS

While all the features of the project involve the usual engineering practice, there are some points connected with the construction of the Deer Creek Dam which might be considered of special importance and interest:

1. Prior to the time of advertising for the construction of the dam, the heavy growth of brush and trees was cleared from the dam site. This proved to be very advantageous to prospective bidders in the inspection of foundation and abutment conditions. It also greatly facilitated the making of the final construction surveys. The quickness with which these surveys were completed no doubt offset the cost of the clearing work.

2. In addition to the rather extensive diamond drill work accomplished in the river bottom and on the abutments of the dam, a 12-in. test well was drilled on the line of the cut-off trench about midway between the two abutments. With the use of sampling apparatus, continuous samples were obtained for a diameter of 8 in. for the entire depth of the well. These samples were made available to the prospective bidders and furnished rather definite information as to the nature of the materials to be encountered in the cut-off trench.

3. The three borrow pits for embankment materials were largely zoned before bids were called for. As the materials consist of rather deep alluvial deposits which can easily be moistened before they are transported to the dam, provisions are included in the specifications requiring the contractor to moisten all materials in place through irrigation or other methods.

4. In order to reduce the gamble in unwatering the foundation, the specifications provide that any pumping from the foundation in excess of 15 cu ft per sec will be done by the United States or, if done by the contractor under methods meeting the approval of the contracting officer, will be paid for as additional work.

Some Practical Observations on City Traffic

Experience in Buffalo, N.Y., Emphasizes the Value of the Three "E's" of Traffic Control—Engineering, Education, and Enforcement

FROM A PAPER PRESENTED BEFORE THE CITY PLANNING DIVISION AT THE SOCIETY'S FALL MEETING

By ELWIN G. SPEYER

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING AND CONSTRUCTION ENGINEER, BUFFALO, N.Y.

THE writer's interest in traffic conditions in Buffalo began in 1931, when he was employed as adviser to the police department in matters relating to traffic control. His experience in this engagement developed certain concepts that seem generally applicable.

It should perhaps be emphasized first that the proper solution of the traffic control problem in any city calls for a thorough traffic survey. In Buffalo our survey required 17 months and covered all seasons of the year. The resulting report has been useful in many ways. It not only served as the basis for the major street plan adopted in 1937, but prior to that date it had been in almost daily use by merchants, trucking companies, gasoline companies, and advertising firms.

The attitude of the general public toward the traffic control work in Buffalo is doubtless typical of that elsewhere, and generally is not helpful. The public's attitude is one of criticism and irritation, as each individual has his own ideas of how traffic should be regulated, and is quick to criticize officials if they do not follow his opinions. His ideas may be sound in themselves, but they are often impractical when all the contributing factors are taken into consideration.

Popular ideas about traffic conditions are frequently very far from the facts. For example, in 1931 the constant cry of the Buffalo newspapers was the evils of congestion and the delays to traffic on the main arteries. However, when the matter was looked into, it was soon discovered that traffic in Buffalo was moving as fast as, if not faster than, that in all the other cities investigated. The public was informed of these favorable comparisons both through the newspapers and through two time zone maps which were widely distributed.

In all traffic control work the idea of safety should be uppermost. In Buffalo we attempted to stress safety in various ways. One was to ask the newspapers to play up prominently the injuries and deaths caused by traffic.

Early in our survey we discovered that 85 to 90 per cent of the deaths in the city were pedestrians killed at crossings by vehicles operated at high speed. Less than 15 per cent of these fatal accidents occurred in the most congested section of the city, that is, within a mile of the city hall. Hence pedestrians were urged to be more alert when crossing streets and to use the regular crosswalks. At the same time we tried to impress drivers with the fact that the pedestrian has the right of way—also that they should observe the ordinance requiring a decrease in speed to 15 miles an hour when crossing at intersections.

This brings up the subject of education as applied to traffic control. Although the records indicate that it is the adults who are most in need of it, the emphasis today is on the children. In Buffalo a monthly letter is sent to all the schools, stressing the bad results of poor observance of traffic rules. For instance, a recent letter contained a statement of the number of children killed and injured in the first eight months of 1937 and 1938, and called attention to the necessity for registering bicycles and to the rules to be observed for their safe enjoyment. Inclosed in the letter was a safety poster and traffic lessons for each age group, as published by the National Safety Council. In addition, the police department attempts to give to all pupils in the public schools at least one lecture a year, illustrated with motion pictures.

Since 1936 Buffalo has had a Safety Commission. This Commission, in cooperation with the police department, has distributed thousands of pamphlets stressing pertinent information taken from the traffic ordinances, and listing rules for motorists and pedestrians.

As regards enforcement, among the most serious problems generally encountered are (1) that traffic ordinances are obsolete, (2) that the police department is in a quandary as to how the ordinances should be interpreted, and (3) that the police department and the courts do not work in harmony. All these conditions were encountered in Buffalo and have not yet been satisfactorily corrected.

In New York State the situation is especially complicated by the fact that there is a serious question as to what powers the local city government can legally delegate to the police department under the State Vehicle and Traffic Law. All municipalities in New York State (except New York City) face this problem, and it is not an easy one.

As a result of his studies in Buffalo and elsewhere, the writer has come to believe that the four most serious problems in municipal traffic control today are:

1. Continual conflict of authority between the city government and the police department. It is suggested that municipal legislative bodies grant more authority and responsibility to the police department.

2. The pedestrian's desire to travel the shortest distance between two points. It is inherent in the training and experience of the American people to seek to accomplish a job as quickly as possible, with the least amount of effort. Here education backed by as little enforcement as possible will evenutally create an alert pedestrian seeking to travel in the safest way.

3. The much too frequent attempts of automobile drivers to start today and arrive yesterday. Manufacturers of automobiles and those in control of traffic are constantly subjected to pressure from the public to produce respectively faster vehicles and streets adapted to greater speeds. Over 90 per cent of the fatal accidents today are chargeable to too much speed, and not to a lack of safety devices on vehicles.

4. The unexplained and inhuman conduct of the average automobile driver. It is a rather sad comment that the average individual, courteous and considerate though he may be in the ordinary pursuits of life, when seated behind the wheel of a car becomes a selfish, egotistical tyrant. It would seem that the only help here would be a closer application of the Golden Rule.

The Maximum Probable Flood and Its Relation to Spillway Capacity

By S. M. Bailey *and* G. R. Schneider

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Doubtless the concept of a "50-year flood" or a "100-year flood" has its place in the economic analysis of flood control projects. But it is a tenuous concept at best, and one may seriously question whether it should ever be applied in determining the proper spillway capacity for a dam. Certainly the "rational" method, which has been developed in recent years, takes into account more of the important factors affecting flood flows than does any variation of the so-called "probability" method. In its use, however, the question arises of what storm, or maximum probable rainfall, should be "transposed" to the drainage area in question. The special contribution of Messrs. Bailey and Schneider in the accompanying article is a set of isohyetal maps which go far towards answering this question. In addition to explaining the construction of these maps the authors discuss their application, concluding with a brief step-by-step summary of the procedure of estimating spillway capacity.

Disastrous floods throughout the United States during the past few years make the subject of the "maximum probable flood" one of timely interest. The relationship of this flood to spillway capacity is a fundamental consideration in the design of dams. Such projects are now being proposed by the hundred, and the majority of them will necessarily be of a type that cannot be overtopped without catastrophe. Many of the dams will have uncontrolled spillways because such spillways are frequently less costly than other types, and because, when adequately designed, they afford assurance against disaster from human or mechanical failure.

As a basic factor in the design of a reservoir project, it is frequently necessary to make a rough estimate of the spillway capacity required, for use in preliminary designs of the various structures. This estimate may have to be made while the hydraulic studies are still in a very preliminary stage. If the final determination of the spillway capacity required differs materially from the initial estimate, radical revisions in the design of the project structures may be involved. This is particularly true when it is planned to incorporate spoil from the spillway excavation in the impounding structure.

Flood control studies in which the writers were engaged in the Ohio Valley and in the Southwest led to the development of the isohyetal maps presented in this article, which facilitate the application of the most recently developed methods for determining the required spillway capacity. They are presented, with a brief outline of their application, with the thought that they will be useful to others. The idea of the isohyetal maps originated with three-dimensional diagrams used to illustrate the decrease of rainfall with increase of distance from the Gulf coast, as shown in the accompanying photographs.

Probability, or frequency, methods have been used as one of the criteria to determine the adequacy of a spillway. Such studies are of value in work where the possibility of insufficient capacity on rare occasions does not involve a threat of serious failure or loss of life. However, the lack of discharge records covering a sufficiently long period prevents the application of these methods to the prediction of the maximum probable flood in many cases.

Envelope curves as devised by Creager, Myers, Jarvis, and others are useful, but by their very nature cannot take into account many of the important factors affecting flood flows. A serious deficiency in this connection is their failure to indicate the volume as well as the peak of the maximum flood. An uncontrolled spillway has available storage capacity above the spillway crest and in most instances will effect a material reduction in the flood peak. In order to evaluate the benefit of this storage, it is essential to know the volume of flow in the spillway-design flood for which provision must be made.

The so-called "rational" method, developed in recent years, whereby storm isohyetals are transposed, a runoff factor determined, and a hydrograph constructed, has proved to be very satisfactory. Credit for the development of this method is due largely to the engineers of the Miami Conservancy District for assembling and publishing data on storm rainfalls; to L. K. Sherman, M. Am. Soc. C.E., for his "unit-graph" method of hydrograph construction (*Engineering News-Record*, Vol. 108, pages 501–505, 1932); and to Robert E. Horton, M. Am. Soc. C.E., for his Publication 101, *Surface Runoff Phenomena Part I—Analysis of the Hydrograph.*

An important condition in the application of this method is to determine the storm or maximum probable rainfall which should be transposed. When given this problem, meteorologists as a rule frankly state that they do not know what the maximum storm might be. They recognize that precipitation decreases with distance inland from the ocean, with increase of latitude, and so forth, but decline to make a quantitative commitment. The engineer, however, must have an answer. Since it is not possible to evaluate the probable maximum precipitation at a given location by determining the limiting forces that produce great storms, recourse must be had to the records of past storms. It is assumed that the maximum precipitation, or something approaching it, has occurred in at least a few places in the country since precipitation records have been kept, and the estimated maxima for the other locations are predicated on such records. It is believed that this is the most logical method of approach to the problem in the present state of our knowledge of meteorological phenomena.

How the Isohyetal Maps Were Constructed

The isohyetal maps, Fig. 1, show the maximum probable precipitation, in inches, to be expected in a single storm at various locations, for drainage areas of various sizes. The maps were constructed by recording, on a similar series of maps, the maximum rainfall depth that had occurred over an area corresponding to that for which the map applied. This depth was plotted at the

storm center. For the map covering drainage areas of 50 sq miles and less (Fig. 1a), which is based on single-station records, some 150 storms were used. For the remaining maps about 80 storms were of sufficient significance to be considered. Full use was made of "Storm Rainfall of Eastern United States, Revised" (Technical Reports, Part V, Miami Conservancy District, Dayton, Ohio, 1936), and these records were supplemented by data on storms that have occurred since the revised publication was prepared.

Sections were taken on the work-sheet maps to develop, in profile, the variations in maximum rainfall depth. One section was taken in a northwesterly direction from the southwest corner of Louisiana to the northwest corner of Minnesota. Another was taken from southern Mississippi northeastward through central Ohio; another along the eastern coast of the United States; still another about normal to the coast line, passing through South Carolina and central Illinois; and another, also normal to the coast line, through New Jersey and Pennsylvania. On each section, at the proper distance inland from the coast, which was used as the initial point, were plotted the depths of rainfall of the greatest storms in the immediate vicinity of the section, the storm centers being projected to the line of the section when necessary. Envelope curves were then drawn on each section enclosing the greatest rainfall depths.

The envelope curves for the different-sized areas were constructed so as to be consistent with each other. Points corresponding to the depths for which isohyetals were to be plotted were then transferred from the envelope curves to the work-sheet maps and the isohyetals were sketched thereon, using both the points from the envelope curves and the depths originally plotted at the storm centers. This resulted in the maps of Fig. 1, which show the depth of the maximum single-storm rainfall to be expected on drainage areas of various sizes, the depth being read or interpolated at the geographic center of the drainage basin under consideration.

INTERPOLATING FOR BASINS OF SIZES NOT SHOWN

For basins of sizes not shown, the depth may be obtained by interpolation between two of the maps. For example, to obtain the maximum probable single-storm rainfall on an area of 1,000 sq miles in Central Iowa, refer to Fig. 1(b), which shows 13 in. as the maximum to be expected over 500 sq miles at this location; and to Fig. 1(c) which, by interpolation, shows that about 11.5 in. may

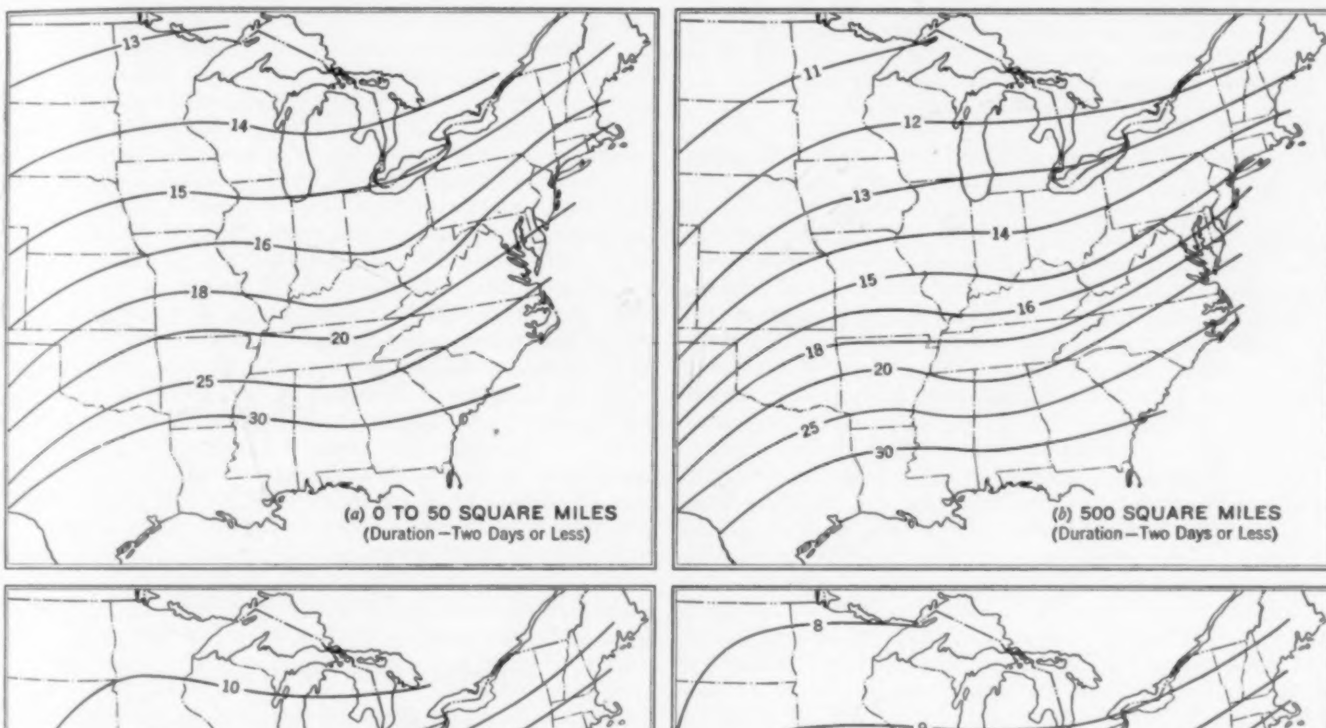
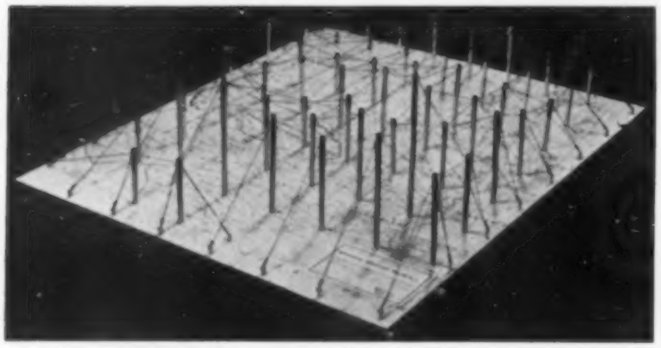


FIG. 1. MAXIMUM PROBABLE STORMS FOR DRAINAGE AREAS OF VARIOUS SIZES
The Isohyetals Give the Average Depth Over the Area, in Inches

be expected on an area of 1,500 sq miles whose center is at the same place. Interpolating between 11.5 and 13 in. gives the result of 12.25 in., which is the probable maximum rainfall over the area of 1,000 sq miles.

The isohyetals presented are based on storms up to and including five days of recorded precipitation, but it should be remembered that a storm lasting little more



RELATION BETWEEN DEPTH OF MAXIMUM STORM RAINFALL AT SINGLE STATIONS AND DISTANCE FROM GULF OF MEXICO, FOR GREATEST STORMS THAT HAVE OCCURRED IN THE MIDDLE AND SOUTHWESTERN UNITED STATES

The Upper Wire on the Pegs Connects Points Representing the Maximum Cumulated Rainfall at a Single Station in the Quadrangle for a Five-Day Period; Similarly the Lower Wire Represents the Maximum One-Day Rainfall

than 72 hours can be recorded as a five-day storm. Also, there are numerous instances where the one-day precipitation approaches or even exceeds the previous five-day record. For example, the March 23–27, 1913, storm in Ohio averaged about 11 in. over a 500-sq mile area. In an isohyetal map presented by T. T. Knappen, M. Am. Soc. C.E. (*Engineering News-Record*, November 14, 1935), the August 6–7, 1935, storm over the Muskingum basin in Ohio averaged 9.5 in. over an area of the same size in about 14 hours. Or again, the storm which caused the great flood on the Ohio River in January 1937 produced about 11 in. of rain in five days over an area of 10,000 sq miles; and yet the October 4–6, 1910, storm, in about the same location, produced an equal amount of precipitation in only three days. The duration to be assumed for the storm is a function of the size of the basin, and in some parts of the region shown it is also a function of the season in which the storm is assumed to occur. Severe storms occurring during the winter and early spring months do not have the high intensity of the summer storms, but the runoff factor is usually much greater.

It is believed possible that the precipitation shown in Fig. 1(*a*) and 1(*b*) (areas up to and including 500 sq miles) may fall within 24 hours as part of a tropical hurricane or a storm of the "cloudburst" type, but under these conditions the runoff factor would probably not exceed 60 per cent on a fair-sized drainage area with good vegetation and soil cover, or 90 per cent if the vegetation and soil cover are thin and the slopes steep. On the other hand, if such precipitation should occur in a season when runoff rates would exceed these percentages, due to previously saturated or frozen ground, the minimum duration probably would be two days, with the possibility that 70 per cent of the precipitation would fall in one 24-hour period. Over a 1,500-sq mile area under highest runoff conditions, the maximum storm probably could occur in two days but the rainfall would be more evenly divided between the days than over the smaller areas. On the 5,000-sq mile area it might continue over a three-day period. If discharge records are available, the duration to be assumed for the storm will be indicated to some extent in the flood hydrograph, which is discussed later.

ESTIMATING THE VOLUME OF RUNOFF

So many variables affect the runoff factor that it is not desirable to enumerate them here. In the region subject to winter and early spring frontal-type storms, runoff factors are likely to approach 100 per cent, because the maximum storm may occur as the culmination of a wet period. In some instances it may be necessary to allow for snow melted by the warm air accompanying the storm, or for the storm occurring at a time when the streams are running full because of snow-melt. In other parts of the country, where maximum runoff factors in excess of 30 per cent, or even less, are improbable, it is more difficult to estimate the maximum. Since the intensity of the rainfall is one of the most important factors in such areas, the minimum depth of rainfall that produced runoff from past storms may prove a better measure of the flow to be expected from the maximum storm than the percentage of runoff from previous large storms. It may be assumed that the characteristics of the maximum storm are similar to those of past storms, and that the amount of water retained by the soil and lost by evaporation can be measured by the minimum depth which produced runoff in the past. This minimum depth can be ascertained by computing the volume of rainfall in excess of certain selected depths and plotting a curve with depths of rainfall as ordinates and the volume of rainfall in excess of the given depth as abscissae. The minimum depth which produced runoff can be read from this curve, it being the depth which corresponds to the volume of runoff from the storm. This depth will vary from zero, corresponding to 100 per cent runoff, to perhaps 2 in. or more for a single day's rainfall. However, it should be remembered that no method of computation can make up for a lack of basic data, and that where rainfall stations are separated by distances of 40 or 50 miles it is hardly likely that the measurements afford a very reliable index of volume of rainfall.

Soil and geologic maps can be consulted to advantage. Sand-dune areas, for example, can be eliminated as noncontributing. Contour maps may show "playa" lakes into which the drainage flows from considerable areas, to evaporate or seep away without affecting floods. Soil erosion maps give valuable indications as to areas producing rapid runoff. The engineer must depend largely upon judgment and experience in such areas.

THE SHAPE OF THE HYDROGRAPH

The rainfall-collection characteristics of a drainage basin are reflected in the shape of the hydrograph. Whenever possible, a unit-graph based on discharges during floods at the place being studied should be used. The procedure may be simplified sometimes by assuming the time period for the unit-graph to be that of previous floods of short duration instead of setting up graphs for daily rainfall. This eliminates a detailed study of the duration to be assumed for the maximum storm, since it gives it characteristics similar to previous storms of short duration and high intensity. Where, as is too often the case, no discharge records are available, the hydrograph must be assumed on the basis of the known hydrograph of a similar area.

The shape of the hydrograph for the assumed maximum flood has an important bearing on the required spillway capacity. For a given flood volume, the hydrograph with the shortest base and highest peak will give the most severe requirement when the flood is routed

through the proposed reservoir. This should be obvious when inflow-outflow-storage conditions are remembered. A low peak with a wide base permits the discharge of a larger quantity of flow before the peak outflow is reached. Thus, for a fixed set of conditions as to spillway length and elevation, the amount stored, which determines the head on the spillway, will be less, and therefore the maximum discharge will be less.

It is usually very important that the hydrograph represent inflow to the reservoir under "spillway flood" conditions. For example, the hydrograph for a 1,000-sq mile area would be radically changed by the construction of a reservoir having a surface area of 30 sq miles at spillway crest level and 300 sq miles or more of the drainage area within a few miles of the reservoir. In such a case the flow from the upper two-thirds of the basin travels through the reservoir with a velocity approximating that of wave propagation and usually, for all practical purposes, can be assumed to affect the pool at the spillway as soon as it enters the reservoir. On the reservoir area itself the rainfall is of course an immediate and direct accretion. The remaining area may have a "time of concentration" with respect to the reservoir surface of the order of an hour or even less. Brief consideration of the excessive rates of precipitation that frequently occur during severe storms will show that very high rates of inflow to a reservoir are possible under such conditions.

Assumptions usually must be made as to whether the outlets will be fully or partly open or completely inoperative. It is scarcely possible that public opinion would permit closing retarding basin outlets and devoting reservoir storage to use other than flood control in an area as populous as that protected by the Miami reservoirs. In other areas, however, particularly where flood losses are largely agricultural, it is possible that at some future date it would appear advantageous to allocate a considerable part of the storage to navigation, power, or other beneficial use. Improved flood forecasting methods may make it appear possible to give a satisfactory amount of flood protection with less storage, or a period of freedom from floods may result in public indifference and the failure to provide funds for even the small amount of maintenance required for such a structure. Under such conditions the assumption that normal outlets are inoperative and that the pool is full to spillway crest level at the start of the spillway-design flood may be entirely proper.

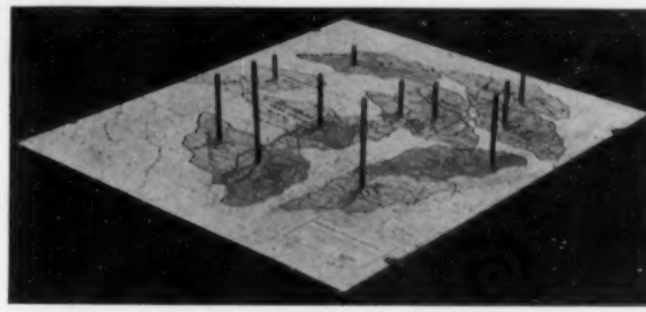
Whether provision should be made for waves due to a high wind occurring when the pool is at its maximum elevation should also be considered. In addition it is well to remember that most earth and rock fill dams settle to some extent, and that, if not properly maintained, what was originally a 5-ft freeboard above the maximum anticipated pool level may in a few years be only a 2- or 3-ft freeboard.

There are certain factors entering into the data presented here that should be brought to the attention of the engineer for consideration in determining the spillway capacity of a reservoir. First, the isohyetals are based on rainfall depths during the greatest storms that have occurred. They include the rainfall in such storms for periods up to five successive days of record. Their positions were fixed not alone by a consideration of storms in the immediate vicinity but also by a study of all the severe storms in the United States. Second, the numerical amounts shown for the various isohyetals are based on area-depth curves. That the isohyetals producing the maximum flood will conform to the outline of the drainage basin, while not impossible, is highly improbable. Third, there is considerable conservatism in applying the unit-graph principle to the compilation of the hydrograph of a maximum flood, because this method does not take into account—or at any rate it minimizes—the effect of the natural storage in the stream valley, which in a large flood tends to lengthen the hydrograph and reduce the peak.

A SUMMARY OF PROCEDURE

Briefly summarized, the procedure in estimating spillway capacity should be as follows:

1. Select the maximum storm rainfall to be expected over the drainage area above the proposed reservoir from



Relation Between Average Storm Rainfall (Over an Area Similar to the Red River Basin Above Denison, Tex.) and Distance from Source of Moisture for the Greatest Storms That Have Occurred in the Middle and Southwestern United States

the chart corresponding to the size of the drainage area, interpolating between charts for intermediate areas and choosing the depth of rainfall indicated by the isohyetals at the center of the drainage area.

2. Determine the volume of this rainfall that may be expected to appear as storm runoff, by multiplying the rainfall by the maximum runoff factor to be expected, or by deducting from the rainfall the minimum depth that may be expected to be lost by percolation, evaporation, transpiration, and so forth.

3. Construct the hypothetical hydrograph of the maximum probable flood by putting the estimated volume of the maximum probable flood under a hydrograph shaped like those of previous floods of short duration, or by constructing a unit-graph for a storm period of one day or less. (If the latter method is used, the probable storm duration must be determined.)

4. Compute outflow curves for assumed spillway lengths.

5. Route the flood through the reservoir, making reasonable assumptions as to conditions of outlets and pool level at the beginning of the flood. (Methods of routing floods through reservoirs have been described in numerous publications, a graphical solution being outlined by R. D. Goodrich, M. Am. Soc. C.E., in the February 1931 issue of Civil Engineering.)

6. Add to the maximum pool levels so obtained, the height deemed necessary to take care of waves and settlement contingencies. This fixes the crest elevation for the dam corresponding to each of the assumed spillway lengths.

7. Plot a curve showing spillway length versus crest elevation of dam. From this the economical combination of spillway length and height of dam above spillway crest can be determined.

In conclusion it may be well to emphasize that the charts submitted herewith (Fig. 1) are not intended to be considered as the final, exact answer to the problem of maximum rainfall. It is believed, however, that they will give safe results suitable for preliminary studies if the runoff factor and hydrograph are properly chosen.

ENGINEERS' NOTEBOOK

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Underflow in Lake Lee, North Carolina

By JACK L. HOUGH

JUNIOR GEOLOGIST, SECTION OF SEDIMENTATION STUDIES, SOIL CONSERVATION SERVICE, U. S. DEPARTMENT OF AGRICULTURE, HIGH POINT, N.C.

UNDERFLOW, the passage of turbid water beneath clear water in a reservoir, has been reported from several localities in the southwestern part of the United States and is now a subject of intensive study by several agencies under the sponsorship of the Interdivisional Committee on Density Currents of the National Research Council. So far as the writer knows, however, there has been no well-established occurrence of this phenomenon reported from the southeastern part of the United States.

During a reservoir silting survey being made by the Section of Sedimentation Studies, Soil Conservation Service, a well-defined underflow was observed in Lake Lee, the municipal water-supply reservoir of Monroe, N.C. This lake (Fig. 1) is composed of two arms, each about 1½ miles in length, which unite a short distance above the dam. The lake is 20 ft deep near the dam and shoals gradually toward the head of each arm. Unfortunately the lack of water-sampling apparatus and thermometers at the time of the flow prevented definite recording of its characteristics, but the observations reported here serve to establish the occurrence of the phenomenon.

During the night of June 7–8, 1938, nearly an inch of rain fell in the drainage area of Lake Lee (0.97 in. was recorded at the Monroe U. S. Weather Bureau Station, about one mile east of the lake). The greater part of this precipitation occurred within an hour around midnight. The next morning about 8 o'clock marked underflow was observed in the lake. Highly colored sediment-laden water filled the stream channels above the limit of backwater and extended about 1,500 ft into the lake before sinking beneath the clear water. Both arms of the lake are narrow in the upper reaches and the turbid water extended from shore to shore. The surface boundary between turbid and clear water at the points where sinking occurred (indicated in Fig. 1) was sharp, forming a clearly marked line convex downstream. A considerable amount of floating debris extended from this line 50 ft or more downstream. The temperature difference between the two water masses was sufficiently great to be readily distinguished with the hand. The inflowing water was colder. A few hundred feet below the line of disappearance of the inflowing water the colder temperature could be distinguished at a depth of about one foot, and turbid water could be raised from this depth by stirring. From the point of sinking to the dam the turbid water occurred at successively greater depths. When an oar was inserted in the lake and swung sharply toward the surface, the water which was raised was either strongly colored or showed no appreciable difference from the surface water, depending upon the depth to which the oar was inserted, thus indicating that the contact between the turbid and overlying clear water apparently remained quite distinct.

Motor boats traveling on the lake stirred up turbid water wherever they went, but only small "boils" of the strongly colored water were brought up in the lower part of the lake, indicating the greater depth of the underflow current in that area. At the dam turbid water was being discharged from a 36-in. diameter pipe, the intake for which is located near the bottom of the lake. The discharge over the spillway, however, though increased in volume over that of the previous day, was not turbid.

The runoff from the previous night's rain was undoubtedly denser than the lake water

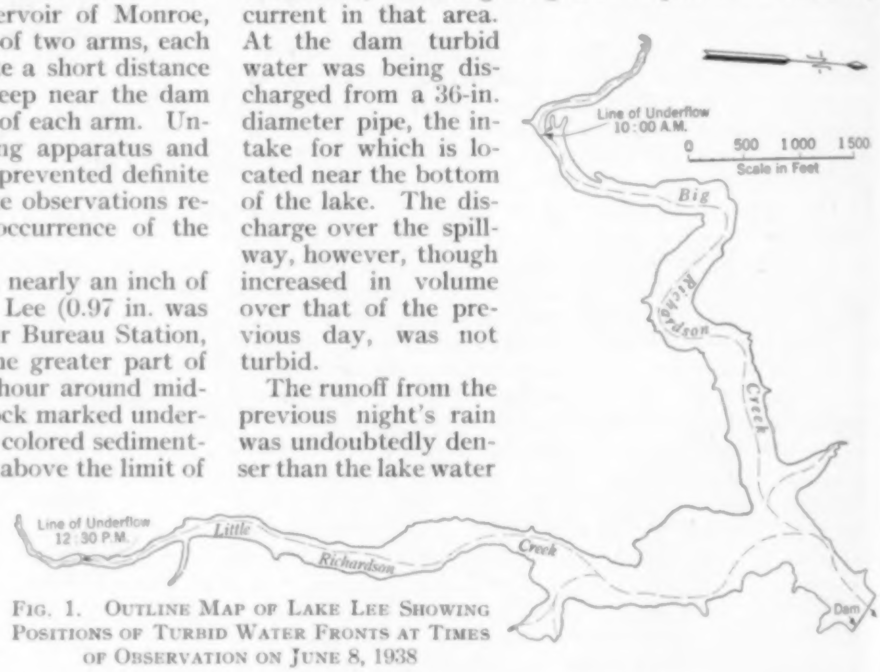


FIG. 1. OUTLINE MAP OF LAKE LEE SHOWING POSITIONS OF TURBID WATER FRONTS AT TIMES OF OBSERVATION ON JUNE 8, 1938

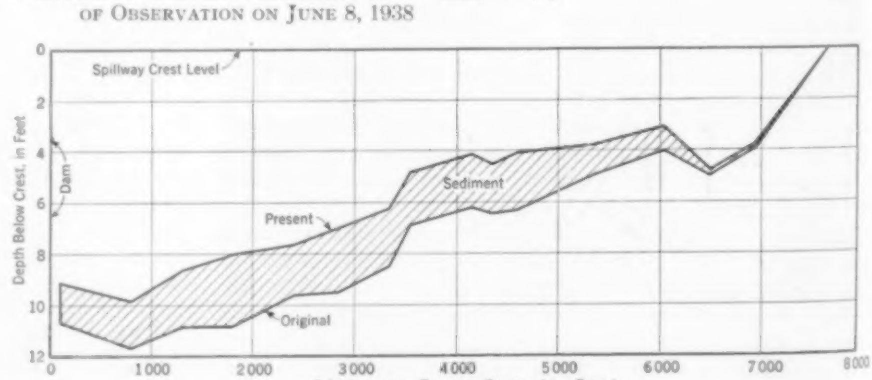


FIG. 2. LONGITUDINAL PROFILE OF LAKE LEE SHOWING AVERAGE DEPTHS, ORIGINAL AND PRESENT, IN BIG RICHARDSON ARM

Conditions in the Other Arm Are Similar

because of its sediment content and its lower temperature. It flowed along the bottom as a sheet-like current and caused clear water to rise and pour over the spillway. In this way clear water was lost while the turbid water was retained in the reservoir, where it would deposit its load of sediment and thereby destroy storage space. The amount of sediment-laden water discharged by the outlet in the base of the dam was small compared with the amount of clear water lost over the spillway.

The occurrence of such well-developed underflow in Lake Lee may be due, at least in part, to the type of rock within the watershed. The Monroe slate, an extremely fine-grained water-laid tuff, which underlies most of the drainage area, weathers to form very fine-grained sediment which stays in suspension readily even in a current of very low velocity. A study of the sediment in the lake has shown the absence of sand deltas at the mouths of the two major streams. A deposit of almost uniformly fine-grained silt and clay covers the bottom and increases in thickness toward the dam (Fig. 2). Lateral variation in thickness and grain size is small. These characteristics of the sediment indicate the absence of sorting by deposition of progressively finer particles from a diminishing current, and thus indicate that underflow may be of common occurrence in Lake Lee.

Square Concrete Sections Subjected to Thrust and Diagonal Bending

By Paul Andersen, Assoc. M. Am. Soc. C.E.

Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn.

In Fig. 1 is shown the case of a square reinforced-concrete column subjected to the action of a direct concentric load, P, and two equal bending moments of magnitude M. The stresses thus produced in the column will be identical with those caused by a single concentrated load of magnitude P, acting at a point on the diagonal a distance of $M\sqrt{2}/P$ from the intersection of the two diagonals. Formulas for the position of the neutral axis and maximum stresses are developed here. (This analysis is a logical continuation of a previous article by the writer, entitled "Diagonal Bending of Square Concrete Sections," which appeared in the August 1938 issue of Civil Engineering.)

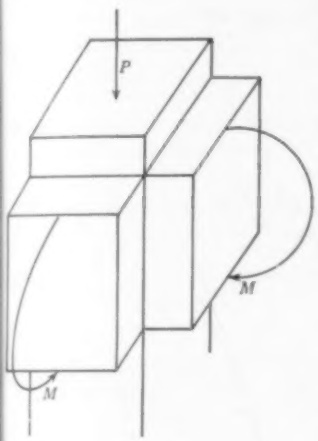


Fig. 1

The following symbols are used:

A_s = cross-sectional area of one reinforcing bar
C = coefficient of resistance
D = length of diagonal
e = eccentricity
d = distance from corner to reinforcing bar
f_c = maximum compressive stress in concrete
f_s = maximum tensile stress in reinforcing bars
k = distance from apex of compression area to neutral axis, divided by D
M = bending moment
n = ratio of moduli of elasticity
p = steel ratio = $8A_s/D^2$
P = load on section

If a square reinforced-concrete section is subjected to the influence of a bending moment caused by a force lying in a plane through the two opposite edges, then the neutral axis will be parallel to the diagonal connecting the two other corners. Depending on the eccentricity of the force, P, the neutral axis may be above the other diagonal as shown in Case 1 (Fig. 2); or it may lie below, as indicated in Case 2 (Fig. 2). In the former case tension will exist in three reinforcing bars; in the latter case the tension will be resisted by only one bar.

The position of the neutral axis is found by eliminating P between the two equations expressing zero sum of all external and internal forces, and zero sum of all external and internal moments with respect to diagonal DE. The slight reduction in the compression area of the concrete caused by the presence of the steel has been neglected, as is usually done in problems of this nature.

Case 1. The compressive stresses form a tetrahedron the centroid of which is $kD/2$ from the apex. The two

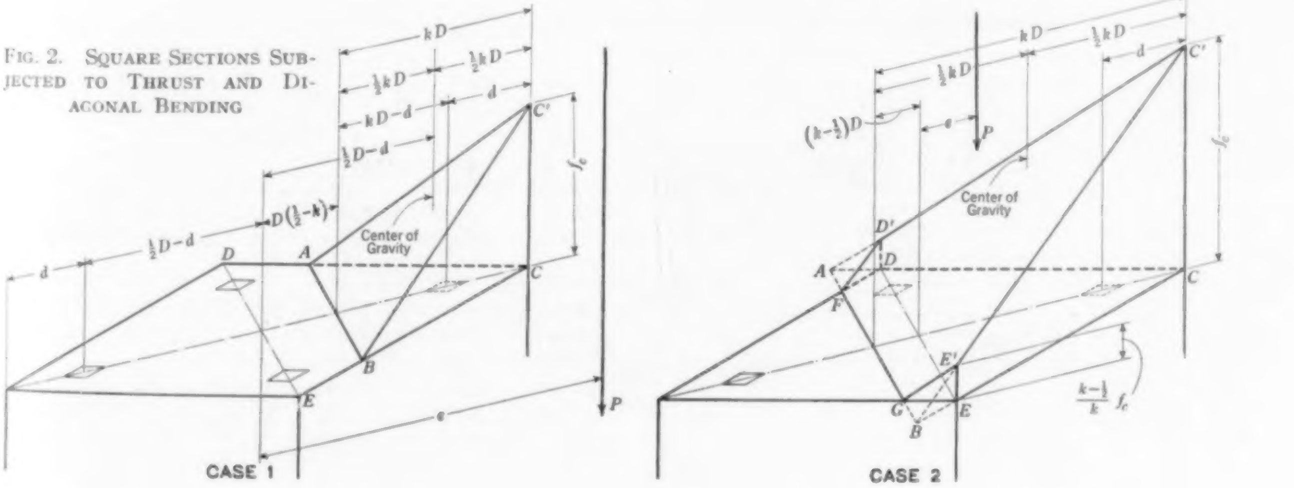


Fig. 2. Square Sections Subjected to Thrust and Diagonal Bending

equations expressing equilibrium of forces and moments are:

$$\frac{1}{3}f_ck^2D^2 + \left(1 - \frac{d}{kD}\right)f_cnA_s - \frac{1-2k}{k}f_cnA_s - \frac{D(1-k)-d}{kD}\,f_cnA_s = P \quad \ldots\ldots [1]$$

$$\frac{1}{3}f_ck^2D^2\frac{D}{2}(1-k) + \left(1 - \frac{d}{kD}\right)f_cnA_s\left(\frac{D}{2} - d\right) + \frac{D(1-k)-d}{kD}f_cnA_s\left(\frac{D}{2} - d\right) = Pe \quad \ldots\ldots [2]$$

Substituting $pD^2/8$ for A_s in Eqs. 1 and 2, and eliminating P gives:

$$k^4 + k^3\left(2\frac{e}{D} - 1\right) + 3pn\frac{e}{D}k - \frac{3}{2}pn\left[\frac{e}{D} + \left(\frac{1}{2} - \frac{d}{D}\right)^2\right] = 0 \quad \ldots [3]$$

Case 2. The compressive stresses form a volume which can be conveniently considered as the volume of the large tetrahedron $ABCC'$ minus the volumes of the two smaller tetrahedrons $AFDD'$ and $GBEE'$. The two equations expressing equilibrium of forces and moments are:

$$\frac{1}{3}f_ck^2D^2 - \frac{2}{3}f_c\frac{\left(kD - \frac{D}{2}\right)^3}{kD} + \left(1 - \frac{d}{kD}\right)f_cnA_s + \frac{2k-1}{k}f_cnA_s - \left(\frac{1-k}{k} - \frac{d}{kD}\right)f_cnA_s = P \quad \ldots [4]$$

$$\frac{f_cD^3}{6}k^2(1-k) + \frac{f_cD^3}{3k}\left(k - \frac{1}{2}\right)^4 + \left[\left(1 - \frac{d}{kD}\right)f_cnA_s + \left(\frac{1-k}{k} - \frac{d}{kD}\right)f_cnA_s\right]\left(\frac{D}{2} - d\right) = Pe \quad \ldots [5]$$

Proceeding as in Case 1,

$$k^4 + k^3\left(2\frac{e}{D} - 3\right) - k^2\left(6\frac{e}{D} - 3\right) - k\left[1 - 3\frac{e}{D}(1 - pn)\right] + \frac{1}{8} - \frac{e}{2D} + \frac{3}{2}pn\left[\frac{e}{D} + \left(\frac{1}{2} - \frac{d}{D}\right)^2\right] = 0 \quad \ldots [6]$$

It should be noted that Eq. 3 is to be used for values of k not exceeding $\frac{1}{2}$, and Eq. 6 for values of k greater than $\frac{1}{2}$. In practice, however, Eq. 3 can be used for values of k considerably greater than $\frac{1}{2}$ because the correction caused by the two small tetrahedrons does not become appreciable until k exceeds about 0.65.

In Figs. 3 and 4 are plotted values of k as functions of e/D and pn. Two ratios of embedment, d/D, have been assumed—namely, 0.1 and 0.2.

The equation expressing the maximum concrete stress in Case 1 is obtained by solving Eq. 1 with respect to f_c.

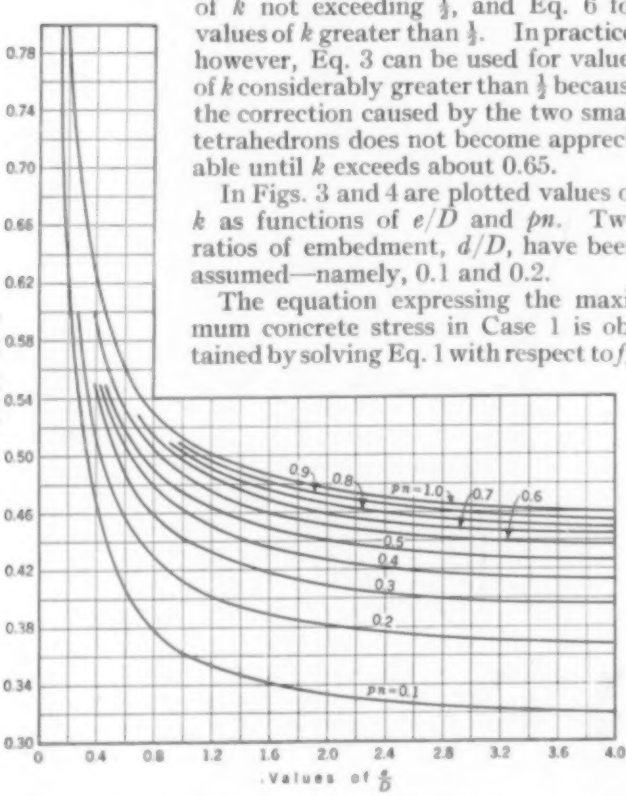


Fig. 3. k AS FUNCTION OF e/D AND pn, FOR $d/D = 0.1$

There results:

$$f_c = C_1\frac{P}{D^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

in which
$$C_1 = \frac{12k}{4k^3 + 6pnk - 3pn} \quad \ldots\ldots\ldots\ldots [8]$$

Similarly, for Case 2, f_c is obtained from Eq. 4, and is expressed by

$$f_c = C_2\frac{P}{D^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots [9]$$

in which

$$C_2 = \frac{12k}{-4k^3 + 12k^2 + 6k(pn - 1) + 1 - 3pn} \quad \ldots [10]$$

In both cases the maximum stress in the tensile reinforcement can be found thus:

$$f_s = nf_c\left(\frac{1-k}{k} - \frac{d}{kD}\right) \quad \ldots [11]$$

As a numerical example, let us find the maximum stresses in a square concrete column (15 by 15 in.) due to a direct load of P = 5,000 lb and two bending moments $M_1 = M_2$ = 12,500 ft-lb. The column is reinforced with four $1^1/_4$-in. round bars, placed 9 in. between centers. It can be assumed that n = 12.

The computations are most conveniently arranged as follows:

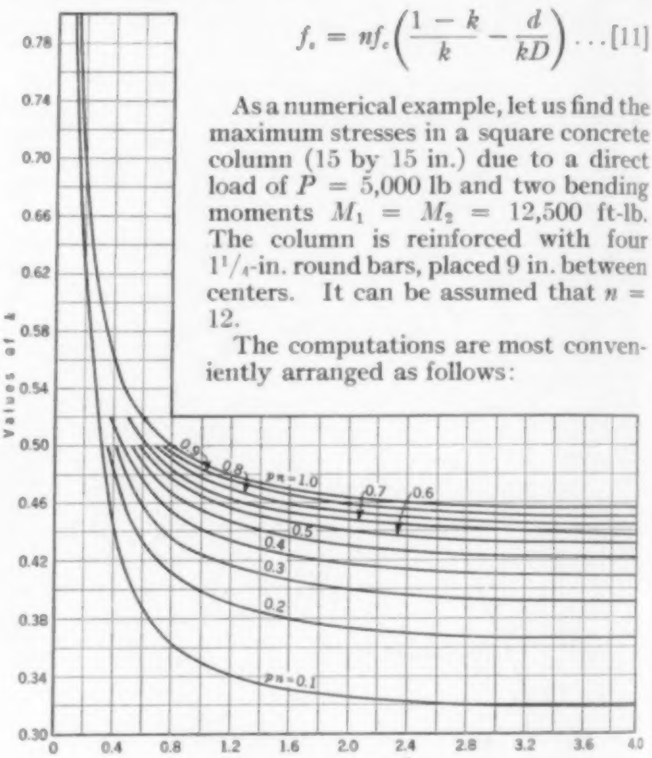


Fig. 4. k AS FUNCTION OF e/D AND pn, FOR $d/D = 0.2$

$$e = \frac{12{,}500}{5{,}000} \times \sqrt{2} \times 12 = 42.42$$

$$\frac{e}{D} = \frac{42.42}{21.21} = 2 \qquad \frac{d}{D} = \frac{3}{15}\left(\frac{\sqrt{v_2}}{\sqrt{v_2}}\right) = 0.2$$

$$p = \frac{4.91}{225} = 0.0218 \qquad pn = 0.2616$$

Substituting the values for $\frac{e}{D}$, $\frac{d}{D}$, and pn in Eq. 3 gives $k^4 + 3k^3 + 1.5696k - 0.8201 = 0$, and solving for k by trial gives $k = 0.39$. This value could also have been obtained from Fig. 4 by interpolating between the curves corresponding to $pn = 0.2$ and $pn = 0.3$. The maximum compressive stress in the concrete and the maximum tensile stress in the reinforcement can be found by Eqs. 7 and 11, respectively, to be 797 lb per sq in. and 11,460 lb per sq in.

Skew Profiles

By Roy N. Towl, M. Am. Soc. C.E.
Consulting Engineer, Omaha, Nebr.

The method of plotting river profiles illustrated here was devised to make possible the proper showing of ordinary profile slopes throughout an area being studied and at the same time to permit very compact horizontal measurements.

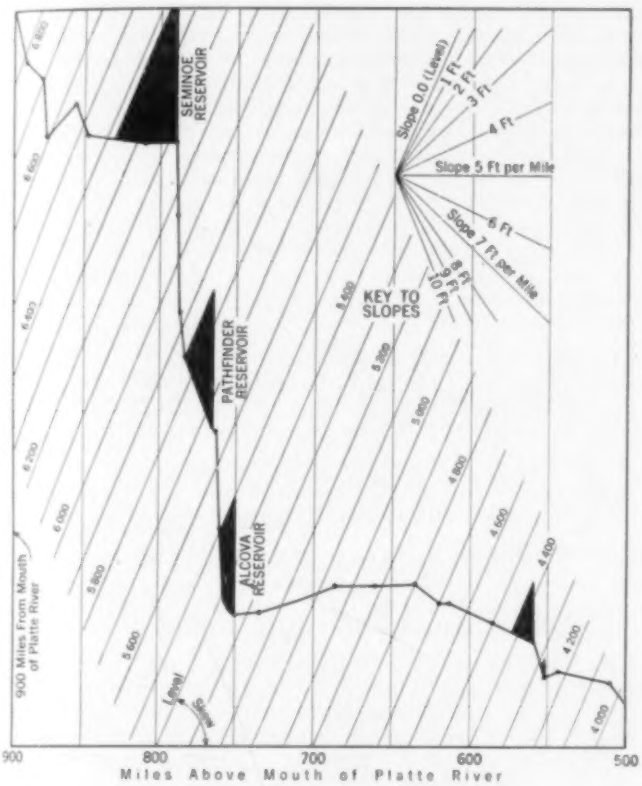


Fig. 1

Two examples should suffice to indicate the value of the "skew profile." Figure 1 shows a 400-mile stretch of the Platte River, in which the total rise is about 3,000 ft. The profile gives a satisfactory slope picture for most of the distance. The vertical measurements may all be scaled from the skew lines, and all changes of slope are clearly indicated.

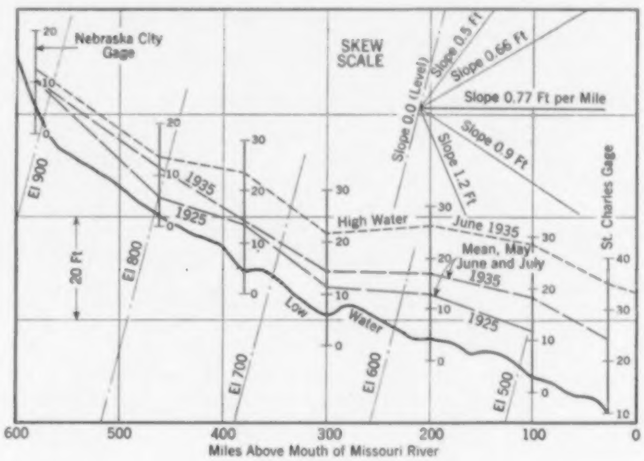


Fig. 2

In Fig. 2 is shown the Missouri River from Plattsmouth, Nebr., to St. Louis, Mo.—a distance of 600 miles. The vertical scale is 20 ft per in., the horizontal scale 100 miles per in. This results in marked contrast for all changes of slope, and permits showing all gages on the river; low water; mean stages for May, June, and July of 1925 and 1935; and high water for 1935. These elevations indicate clearly changes of several feet at certain stations with very little change at other stations.

This method reveals the whole situation in compact form, with all the details ordinarily supplied by regular profiles. It is the only method whereby condensed profiles can be made and at the same time present the desired slope angles at readable scales.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Closure of Comments on Flood Routing

To the Editor: In the October 1938 issue of Civil Engineering, John W. Hackney presented a method of flood routing in the form of a comment on my article on flood routing in the July issue. Perhaps a few remarks as to the relative merits of the two methods would not be out of place.

First, the method outlined by Mr. Hackney does not give a complete solution to the problem, since it is sometimes imperative, particularly in my work, that both the final outflow and storage be determined.

Second, since what Mr. Hackney refers to as the "M-curves" is also a function of the time interval, Δt, ($M = O/2 + S/\Delta t$), then for every different value of Δt it is necessary to draw a new series of M-curves.

The advantage of using the method described in my article is that once the relation between the outflow and storage, or flow-storage curves, has been drawn, these curves will apply to all values of Δt, with the variation in Δt being taken into account by varying the "slope" of the storage factor, or M-scale.

This is readily done by placing a triangle with its edge intersecting the value of the computed storage factor, "M" on the storage scale, and its slope corresponding to the desired time interval. The desired quantities of outflow and storage are then obtained from the intersection of the edge of the triangle with the flow-storage curve. In fact, in actual computations of flood routing, the above method has often been used in preference to actually drawing in the storage-factor scale.

I. H. Steinberg
Assistant Engineer,
U. S. Engineer Office
St. Paul, Minn.

Deriving the Hypotenuse of a Right-Angled Triangle

TO THE EDITOR: In the October number of CIVIL ENGINEERING, Leonard C. Jordan, M. Am. Soc. C.E., presents a method of quickly deriving the hypotenuse of a right-angled triangle, which appears to be sufficiently accurate when one leg is relatively much smaller than the other. However, when the two legs approach equality, the error by this method becomes maximum and might render the method unsafe if used in design.

This may be illustrated by taking a triangle with legs of 20 ft each. Thus x and y in Mr. Jordan's equation $a = \dfrac{y^2}{2x + a}$ are each 20 ft, and a is the amount to be added to x to become the hypotenuse. The method is as follows: $y^2 \div 2x = 10$, which added to $2x$ becomes the new divisor, giving a quotient of 8. This, by Mr. Jordan's method, is added to x to become the hypotenuse, giving the value of 28 ft. Actually the hypotenuse is 28.284, or about $3\frac{7}{16}$ in. more. The values obtained by this method are always too small.

It may be suggested that if slide-rule computations are of sufficient accuracy, the following method would give fairly close results. First, square the value of y on the D-scale of the slide rule. Then derive a from Mr. Jordan's method and add a small increment to it for a new a to be added to $2x$ for a new division. Perhaps two or three trials will be needed, but these can be quickly made. Set the new divisor on the C-scale under the slider, and if the right value of the increment has been chosen, the correct value for a will appear at the end of the C-scale. Or, in other words, the value of a added to $2x$ for the divisor will give a as a quotient.

By using the D and C-scales a greater degree of accuracy is possible than on the A and B-scales.

Another method that may be performed by slide rule is as follows: Since the hypotenuse is the square root of $x^2 + y^2$, let r = ratio of $y{:}x$ so that H (hypotenuse) $= x\sqrt{1 + r^2}$. This can be done fairly accurately by slide rule and of course contains no error in the equation. Using C and D-scales gives a more clearly defined squaring.

JAMES B. GOODWIN, M. Am. Soc. C.E.

Toronto, Ont., Canada

Deflection of Free-End Column with Eccentric Load

TO THE EDITOR: In the September issue Scott W. Orr, Assoc. M. Am. Soc. C.E., discusses the writer's article on "Deflection of Free-End Column or Hanger with Eccentric Load," in the May issue. Mr. Orr, by the use of Maclaurin's theorem, developed the following equations:

$$\Delta_{\text{column}} = \frac{Pbl^2}{2EI - Pl^2} \cdots (a) \qquad \Delta_{\text{hanger}} = \frac{Pbl^2}{4EI - Pl^2} \cdots (b)$$

A. W. Fischer, of Washington, D.C., by letter, showed a development of the same problem by the slope-deflection method, which gave the following equations:

$$\Delta_{\text{column}} = \frac{3Pbl^2}{6EI - 2Pl^2} \cdots (c) \qquad \Delta_{\text{hanger}} = \frac{3Pbl^2}{6EI + 2Pl^2} \cdots (d)$$

C. L. Christensen, bridge engineer of New York City, showed the writer a development of this problem by the moment-area method.

On the basis that the moment area due to $P\Delta$ is $2\Delta l/3$, Mr. Christensen's equations agree exactly with my original equations, namely

$$\Delta_{\text{column}} = \frac{6Pbl^2}{12EI - 5Pl^2} \cdots (3) \qquad \Delta_{\text{hanger}} = \frac{6Pbl^2}{12EI + 5Pl^2} \cdots (4)$$

and on the basis that the moment area due to $P\Delta$ is $\Delta l/2$, he got equations exactly the same as Mr. Fischer's.

Now, if in the writer's original article, the elastic curve had been assumed to be a straight line, the development would have been as follows:

$$y = \frac{x\Delta}{l} \qquad \therefore \frac{EI}{P}\frac{d^2y}{dx^2} = b + \Delta - \frac{\Delta x}{l}$$

Integrating twice and solving, we would get equations agreeing exactly with Mr. Fischer's Eqs. c and d.

If we give all the equations the same numerator and (for brevity) examine the equations for columns only, we have:

$$\Delta = \frac{6Pbl^2}{12EI - 6Pl^2} \qquad (a')$$

$$\Delta = \frac{6Pbl^2}{12EI - 5Pl^2} \qquad (3)$$

$$\Delta = \frac{6Pbl^2}{12EI - 4Pl^2} \qquad (c')$$

It will be seen that the only differences between these equations occur in the last terms of the denominators, and as Pl^2 is small compared with $12EI$ the variations in the values of Δ will be quite small.

An index of work done is the moment area and, regardless of the methods used in developing these equations, the moment areas due to $P\Delta$ for the three equations under comparison are as follows:

$$\text{Eq. } (a')\text{: moment area} > \frac{2l\Delta}{3}$$

$$\text{Eq. (3): moment area} = \frac{2l\Delta}{3}$$

$$\text{Eq. } (c')\text{: moment area} = \frac{l\Delta}{2}$$

In conclusion, the writer would like to express the opinion that Mr. Orr's Eq. (a) is a little more accurate than the writer's Eq. (3) and that Eq. (3) is a little more accurate than Mr. Fischer's Eq. (c).

It appears that Mr. Orr's Eq. (b) should be as follows:

$$\Delta = \frac{Pbl^2}{2EI + Pl^2}$$

E. R. ST. JOHN, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.

Additional Fatigue Tests Urged

TO THE EDITOR: The "Fatigue Tests of Riveted Joints," reported by Wilbur M. Wilson in the August issue, have been characterized as the greatest piece of research Professor Wilson has ever done. Yet in the complete description of these tests (Bulletin #302 of the University of Illinois Experiment Station), Professor Wilson indicates that he considers these experiments as pilot tests only, and as merely pointing the way toward a more complete investigation.

The values found for the fatigue strength of structural materials check very well with the results of other tests, and there appears little reason to believe further tests would show materially different values. The results are such that designers must question the practice of using alloy steels in members subject to reversals or to large variations of stress. In ordinary structures, the members subject to large unit stress range have such low total stresses that carbon steel may be used without serious disadvantage. In suspension bridges, however, the case is quite different, and alloy steels have been used at unit stresses materially above the limiting fatigue stresses. It is true that the loading producing such unit stresses seldom if ever, occurs. A question then arises as to the comparative fatigue strength of the various grades of steel when subjected to many reversals of moderate intensity and a few reversals of greater intensity.

The tests on the fatigue strength of rivets indicated that the rivets would not fail until a considerable slip occurred. None of the joints tested had more than two rivets in a line in the direction of stress. In a joint with more rivets, it is necessary that the end rivets slip before an equal partition of stress can take place. It is possible, and perhaps probable, that in a joint with several rivets in line, fatigue failure would take place at comparatively low unit stresses.

To make economical and safe designs, engineers require more knowledge along these lines than is now available. I know of no field where additional research is more urgently required, and trust that means of permitting Professor Wilson to complete this work will be found.

GLENN B. WOODRUFF, M. Am. Soc. C.E.

San Francisco, Calif.

Proportioning Spread Foundations for Uniform Settlements

Dear Sir: Raymond F. Dawson's article, "Settlement Studies on San Jacinto Monument," which appeared in the September issue, is one of the clearest and most constructive of recent articles on applied soil mechanics. For the first time the subject of settlement calculations is stripped of the difficulty and complexity with which it has so often been surrounded.

The article is of special interest to the writers because, during the past two years, they have developed and used an almost identical computation as the basis of a method for proportioning spread foundations for uniform settlements. This work was done while the writers were employed in the office of R. V. Labarre, consulting engineer of Los Angeles, Calif.

In making the settlement computations it has usually been found simpler to plot the pressure-consolidation data obtained from tests in terms of load versus percentage of lineal consolidation rather than in terms of voids ratio. The total settlement of the footing is then obtained by a simple summation of the lineal compressions in the various layers resulting from the known changes in load, and does not require the use of $q = (e_i - e_f)h/(l + e_i)$ to convert from units of voids ratio to settlement in inches.

For the use of the foundation designer it has been found helpful to compute load versus settlement curves for the different sizes and shapes of footings required by a particular structure. These data can then be presented in the form of curves showing the sizes of footings required to carry the various loads at any definite uniform settlement. Several curves for different magnitudes of settlement are usually included. The selection of the settlement to be allowed should depend on the nature and use of the structure, the accuracy with which the actual load can be anticipated, and the accuracy of the calculated settlements as estimated from the consistency of the test results.

In buildings having a non-uniform distribution of mass and with footings proportioned for a uniform dead-load soil pressure, or for dead load plus a percentage of the live load, differences of settlement may be expected between adjacent footings of different size and shape. These settlements cause secondary stresses in the frame of the building which may lead to disfiguring cracks, uneven floors, and, in extreme cases, structural failures. If the footings are proportioned for equality of settlement, these undesirable stresses caused by differential settlements are in large measure eliminated, for even though the absolute values of the computed settlements may be somewhat in error, the relative behavior of dissimilar footings can be closely predicted.

The writers have had sufficient success with this method to warrant advocating its use as a more rational method for proportioning foundations than any of the empirical methods commonly found in textbooks and building codes.

William W. Moore, Jun. Am. Soc. C.E.
and
Trent R. Dames, Jun. Am. Soc. C.E.

Los Angeles, Calif.

Proper Installation of Steel Windows

To the Editor: In the June 1938 issue was a brief item by Chester L. Dalzell entitled "Suggestions on the Maintenance of Steel Windows." In this connection the following remarks on proper installation should be of interest.

Motivated by the desire to reduce steel-window maintenance costs to a minimum, the Technical Committee of the Metal Window Institute, some time ago, visited and examined numerous typical old and new installations of various steel window manufacturers. Their object was to determine, if possible, the primary causes necessitating expenditures for maintenance. After an extensive analysis of the findings, it was concluded that in most all cases upkeep could be directly traced to one or both of two factors. First, settling of the building structure and/or excessive deflection of steel lintels, together with the lack of proper slip connections between, lintel and window head, imposed a column load upon the window resulting in its distortion, the opening up of joints, and the destruction of effective connections between masonry and window frame. Second, in a great many instances, the bottom rail of the window was buried deep in a cement sill, prohibiting the proper drainage of water and moisture. In no case was the unequal expansion and contraction between the steel and masonry of any importance.

As a result, a set of recommendations and details was formulated, which, if followed by building designers and builders, should eliminate excessive maintenance expenditures resulting from normal causes. Those recommendations and details, subsequently adopted by all industry members, follow:

1. It is recommended that greater consideration be given to the proper design and construction of steel lintels so that loads imposed thereon will be carried without exceeding their deflection limits. Steel windows and mullions are not constructed to carry column loads.

2. It is recommended that the lintel construction and window installation shall afford a slip connection between lintel and window in strict accordance with standard details of window manufacturers (see Fig. 1).

3. It is recommended that window sills be raised at least 1 in. above the high point of the wash and that the bottom sash rail never be buried in a poured concrete sill.

4. It is recommended that masonry jambs be constructed with an offset to afford ready painting of jamb rails and facilitate easy removal of window.

5. It is recommended that masonry sills be designed and constructed with sharply sloping top surfaces, particularly on the outside, in order to accelerate the drainage of moisture and prevent collection of snow and ice.

6. It is recommended that where maximum window life is a requirement or where the corrosion hazard is severe, windows should be set in a good mastic cement (heads, sills, and jambs) to prevent contact between steel and masonry. This is not offered to absorb expansion and contraction but as a protection to steel surfaces which cannot be painted.

7. It is recommended that windows be given an occasional coat of good paint, the frequency depending entirely upon conditions to which the window is subject. Obviously more frequent paintings are necessary in damp climates than in dry locations.

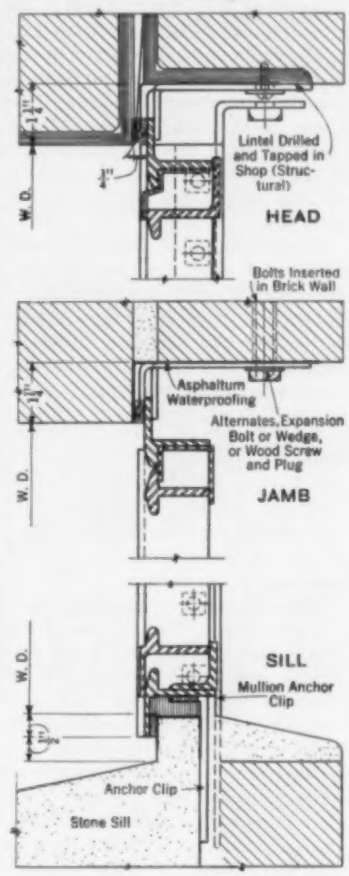


Fig. 1

Myron J. Jones
Technical Assistant, Metal Window Institute

Washington, D.C.

"Such Is Fame"

To the Editor: Such is fame! I note in the bottom of the box on page 857 of Civil Engineering for December that Karl T. Compton is president of the "*Mississippi* Institute of Technology."

Charles W. Sherman, M. Am. Soc. C.E.
Consulting Engineer

Boston, Mass.

[*Editor's Note:* "Mass." did look like "Miss." on the copy that went to the typist; which seems to put it right back in the lap of the editorial staff.]

Studies of Settlement of Structures

TO THE EDITOR: In his article in the November issue Professor Tschebotareff has emphasized the great practical and economic importance of full-scale observations of the settlement of structures. The experience gained in the actual construction of foundations and the records obtained from settlement observations not only serve to build up a very important body of knowledge on soil behavior, but also form the basis for bringing experimental and theoretical soil mechanics to the point where direct practical applications can be made with greater certainty.

The main sources of error in making estimates or predictions as to the distribution and total amount of settlement are: (1) There may be important differences between the actual distribution of stress in the soil produced by a foundation loading and that obtained from the Boussinesq equation; (2) the compressibility of the soil underlying the structure as an integrated quantity for the soil profile cannot, at present, be determined with sufficient accuracy.

It was suggested that the possibility of making accurate forecasts must await the development of a comprehensive program of full-scale "control observations." In the meantime, it is just as essential to have, in each case, as complete information as possible on the subsurface soil conditions, as it is to have accurate systematic settlement records. The soil profile should give a true record of the materials encountered, and quantitative information on the physical characteristics and properties of the soil in the different soil layers so that the materials may be positively identified. When changes in the character of the soils occur, the location and the nature of the change should be definitely indicated. In addition, the number of blows per foot required to drive the casing, and particularly the sampling spoon, gives information of a quantitative character on the relative density of granular, cohesionless soils, and of consistency or stiffness of cohesive, plastic soils.

This information is pertinent to the questions raised by Professor Tschebotareff. The simple Boussinesq theory for an ideal isotropic homogeneous soil mass seldom applies because of the variability and non-uniformity of subsurface soil conditions. The physical characteristics, and particularly the penetration resistance of the sampling spoon and the elastic soil constants, should indicate discontinuities in the soil mass, which may have an important effect on the distribution and intensity of pressure in the different soil layers. A closer approach to actual conditions may then be possible by the use of the theory developed by Prof. M. A. Biot (*Physics*, Vol. 6, No. 12, December 1935). Again the stress distribution for pile foundations can be made to approach more closely to the actual by using the theory developed by Dr. R. D. Mindlin (*Physics*, Vol. 7, No. 5, May 1936) for a point load within a semi-infinite soil mass. However, it must be remembered that, where soil conditions are variable and questionable, the distribution and intensity will probably differ materially from that found by any theoretical considerations.

As to the second point, the importance of the difference between the actual compressibility of the soil deposit as a summation of the individual layers, compared with the results obtained from tests on undisturbed samples, can only be learned by continuous sampling the full depth of the boring in order to obtain a representative profile of soil conditions. Furthermore, representative sampling and testing require improvements in the apparatus and methods used in taking and testing undisturbed samples, so that the results of the test represent actual conditions. Not only is the compressibility of the soil important, but also the initial stress conditions in the soil as defined by the pre-consolidation load of Prof. A. Casagrande. (Paper 34, Vol. III, *Proc. Int. Conf. on Soil Mech. and Found. Eng.*, Harvard, 1936.) This paper has a particular application to those cases cited by Professor Tschebotareff, where the settlement was considerably less than anticipated because the soil had evidently been compressed under a much greater load than the weight of the present overburden.

Although there may seem to be insurmountable difficulties in making reliable, accurate forecasts of settlement, the program of settlement studies and observations outlined by Professor Tschebotareff will do much to bring soil mechanics to the status of a true science.

DONALD M. BURMISTER, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering,
Columbia University

New York, N.Y.

What Was He Drinking?

DEAR SIR: In looking up field notes of the original government survey of a portion of what is now King County, in the state of Washington, near the town of Issaquah, I ran across the following harrowing account of "Edwin Richardson, deputy surveyor under his contract No. 80, bearing date the 1st day of September, 1864."

He was proceeding east on a random line between sections 26 and 35, township 24 north, range 6 east of Willamette Meridian, when at 34.00 chains he arrived at "A point about 5 chains from the northeast shore of Tradition Lake. Note: The ground in this vicinity is almost entirely covered with various species of snakes. They also were knotted together in heaps upon fallen timber and hung dangling from the lower limbs of small trees. Many were also observed devouring or disgorging other snakes of lesser size. Those necessarily crushed beneath our feet filled the air with nauseous stench."

As snakes are almost a rarity in western Washington, there is no ready explanation of the phenomena described. Nevertheless, the account forms a part of the official records of the U. S. government.

Perhaps others have noted comparable experiences of surveyors in early records and will attempt to tie this.

WELLS H. ASHLEY, M. Am. Soc. C.E.

Olympia, Wash.

Study of Cavitation

DEAR SIR: Giro G. Kubo, in an article on "Cavitation and Its Effect on Turbines," in the "Society Affairs" department of the November issue, has produced a very meritorious survey of existing knowledge and opinion on a still fairly abstruse subject.

My attention was arrested mainly by the remarks on the subject of the English Admiralty's study of cavitation in 1915, arising out of the condition of the *Mauretania's* propellers.

Mr. Kubo—and possibly others—will be interested to know that study on the subject of propeller-cavitation was commenced as far back as 1891, following observations made by Burnaby during the trials of an English torpedo-boat. In 1894 the matter was brought to a head by the disappointing speed attained by the *Turbinia*, an experimental vessel built by Sir Charles Parsons to incorporate his first marine steam turbine.

Cavitation by the single high-speed propeller was suspected. Sir Charles attacked this obscure problem with the energy and insight of his great engineering mind. He set up experimental tanks and tried out many forms of propellers, recording the results obtained by means of cameras combined with intermittent light. He was, I believe, the first to apply this stroboscopic method to any serious engineering study. The propellers gave up their secrets, and there was evolved the fundamental principle that, to keep cavitation within the range of control, the projected area of the blades should be 0.7 of the disk area.

Armed with this and other derived knowledge, Sir Charles redesigned the propelling equipment of the *Turbinia*, and the vessel was again tried out in 1897. The results were phenomenal, the speed rising from 18 knots to 34.5 knots, a hitherto unbelievable figure. Application of the steam turbine to marine engineering was established, and within a few years the little 100-ft *Turbinia* was followed by the giant twins, *Lusitania* and *Mauretania*. In spite of this great advance the subject remained, and remains, appropriately a fluid one. The minds of designers, translated to the drawing-board, do not necessarily consolidate the gains of research or reflect current engineering opinion. Finance and the practical limitations of the foundry and machine-shop must also play their part, and the driven propeller and driving impeller represent a compromise between the several factors.

In spite of their high mechanical efficiency, something yet remains to be learned; we still have the paradox that of two propellers or impellers made to the same design one may be rather more efficient than the other in practice and, further, that of two similar propellers or impellers working on the same ship or plant one may become more pitted than the other.

Incidentally, there may be seen in the Science Museum in London the 45-ft after section of the *Turbinia*, complete with the whole propelling equipment, and also a number of the photographs of cavitation research made by Sir Charles Parsons.

London, England T. A. ROSS, M. Am. Soc. C.E.

Eighty-Sixth Annual Meeting

New York, N.Y., January 18–21, 1939

Program of Sessions, Entertainment, and Trips

Business Meeting, Conferring of Honorary Membership, Prize Awards, and Presentation of Hoover Medal

WEDNESDAY—January 18, 1939—Morning

Auditorium

9:00 **Registration**

10:00 **Eighty-Sixth Annual Meeting called to order by**

Henry E. Riggs, *President, American Society of Civil Engineers; Honorary Professor, Civil Engineering, University of Michigan*, Ann Arbor, Mich.

Report of the Board of Direction

Report of the Secretary

Report of the Treasurer

10:30 **Conferring of Honorary Membership**

C. Frank Allen, *M. Am. Soc. C.E., Professor Emeritus, Massachusetts Institute of Technology*, West Roxbury, Mass.

Mr. Allen will be presented to the President by Frank E. Winsor, *M. Am. Soc. C.E., Chief Engineer, Metropolitan District Water Supply Commission, Commonwealth of Massachusetts*, Boston, Mass.

Anson Marston, *Past-President, Am. Soc. C.E., Dean Emeritus of Engineering, Iowa State College*, Ames, Iowa.

Dr. Marston will be presented to the President by T. R. Agg, *Director, Am. Soc. C.E., Dean of Engineering, Iowa State College*, Ames, Iowa.

Arthur S. Tuttle, *Past-President, Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

Mr. Tuttle will be presented to the President by J. P. H. Perry, *M. Am. Soc. C.E., Vice-President, Turner Construction Company*, New York, N.Y.

Edward E. Wall, *M. Am. Soc. C.E., Director, Public Utilities, City of St. Louis*, St. Louis, Mo.

Mr. Wall, who will be represented by F. G. Jonah, *M. Am. Soc. C.E., Chief Engineer, St. Louis–San Francisco Railway*, St. Louis, Mo., will be presented to the President by W. W. DeBerard, *Director, Am. Soc. C.E., Associate Editor, "Engineering News-Record,"* Chicago, Ill.

Frank E. Weymouth, *M. Am. Soc. C.E., General Manager and Chief Engineer, The Metropolitan Water District of Southern California*, Los Angeles, Calif.

Mr. Weymouth will be presented to the President by Thaddeus Merriman, *M. Am. Soc. C.E., Consulting Engineer, Board of Water Supply, City of New York*, New York, N.Y.

11:00 **Presentation of Society Medals and Prizes**

The Norman Medal to Hunter Rouse, *Assoc. M. Am. Soc. C.E., Assistant Professor of Fluid Mechanics, Soil Conservation Service, U. S. Department of Agriculture*, Pasadena, Calif., for Paper No. 1965, "Modern Conceptions of the Mechanics of Fluid Turbulence."

The J. James R. Croes Medal to E. C. Hartmann, *Assoc. M. Am. Soc. C.E., Research Engineer, Aluminum Research Laboratories*, New Kensington, Pa., for Paper No. 1979, "Structural Application of Aluminum Alloys."

The James Laurie Prize to Leon S. Moisseiff, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y., for Paper No. 1979, "Evolution of High-Strength Steels Used in Structural Engineering."

The Arthur M. Wellington Prize to Charles M. Noble, *M. Am. Soc. C.E., With Pennsylvania Turnpike Commission*, Harrisburg, Pa., for Paper No. 1977, "The Modern Express Highway."

The Collingwood Prize for Juniors to Douglas M. Stewart, *Jun. Am. Soc. C.E., Engineer, Ingersoll-Rand Company*, New York, N.Y., for Paper No. 1968, "Behavior of Stationary Wire Ropes in Tension and Bending."

11:30 **Presentation of Hoover Medal to**

John F. Stevens, *Past-President and Honorary Member, American Society of Civil Engineers.*

Introduction by Gano Dunn, *M. Am. Soc. C.E., Past-President, American Institute of Electrical Engineers; Chairman, Hoover Medal Board of Award.*

Statement by Chairman Dunn on history and purpose of the Medal.

Address on the achievements of the Medallist by Ralph Budd, *M. Am. Soc. C.E.*

Presentation of the Hoover Medal to John F. Stevens by Chairman Dunn.

Business Meeting

New Business

Report of Tellers on Canvass of Ballot for Officers

Introduction of President-Elect and New Officers

Luncheon

Fifth floor, Engineering Societies Building. Tickets $1.00 each.

Assist the Committees by Registering and Obtaining Tickets Early

General Meeting, Student Conference, President's and Honorary Members' Dinner, Reception, and Dance

WEDNESDAY—January 18, 1939—Afternoon

SYMPOSIUM ON IMPROVEMENT OF SOCIAL, ECONOMIC, AND PROFESSIONAL STATUS OF THE CIVIL ENGINEERING PROFESSION

Auditorium

The Board of Direction, at its meeting in Salt Lake City, July 1938, authorized the appointment of a Committee on Professional Objectives. Some of the objectives of this committee are:

1. To supplement and strengthen the work of the Board of Direction and the special committees of the Society.
2. To concern itself actively with subjects incident to engineering practice in order to develop and maintain high standards of practice and ethics, promote understanding among engineers and between the profession and the public.
3. To provide an agency through which both salaried and employer engineers may express themselves more freely and effectively on professional matters.
4. To give general consideration to national and state legislation affecting the engineer.
5. To give particular consideration to the economic and social status of the engineer and to national and social trends affecting him.
6. To encourage and demand a wider employment of engineers in engineering and technical works.

The present symposium was arranged primarily for the purpose of learning what other professions have undertaken in the way of advancing the social, economic, and professional status of their members and to give opportunity for members of this Society to present their views and ask questions. Therefore, the committee has arranged for representation from the architectural, legal, and medical professions, as follows:

2:30 (1) **Introductory Statement**

E. R. NEEDLES, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.; *Chairman, Committee on Professional Objectives* (5 minutes).

(2) **Representing the Architectural Profession**

FRANCIS P. SULLIVAN, Washington, D.C.; *Chairman, Committee on Interprofessional Relations, The American Institute of Architects* (20 minutes).

(3) **Representing the Legal Profession**

HAROLD GALLAGHER, *Chairman, Public Utilities Section, American Bar Association; Member of the Legal Firm of Miller, Owen, Otis, and Bailly*, New York, N.Y. (20 minutes).

(4) **Representing the Medical Profession**

DR. CHARLES GORDON HEYD, New York, N.Y.; *Member, Council on Medical Education and Hospitals, American Medical Association* (20 minutes).

(5) **Representing the American Society of Civil Engineers**

CARLTON S. PROCTOR, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.; *Member, Committee on Professional Objectives* (20 minutes).

4:00 **Discussion opened by**

V. T. BOUGHTON, *Assoc. M. Am. Soc. C.E., Managing Editor, "Engineering News-Record,"* New York, N.Y., on the subject of Technical Unions (5 minutes).

H. MACY JONES, *M. Am. Soc. C.E., Secretary, State Board of Registration for Civil Engineers*, Los Angeles, Calif., on the subject of Protective Registration Acts (5 minutes).

STANLEY H. WRIGHT, *M. Am. Soc. C.E., Regional Engineer, Public Works Administration*, Atlanta, Ga. (5 minutes).

DANIEL C. WALSER, *M. Am. Soc. C.E., Vice-President, Charles B. Hawley Engineering Corporation*, Washington, D.C. (5 minutes).

F. N. MENEFEE, *M. Am. Soc. C.E., Professor, Engineering Mechanics, University of Michigan*, Ann Arbor, Mich. (5 minutes).

4:20 **General Discussion**

STUDENT CHAPTER CONFERENCE

Fifth Floor

3:00 **Conference of Student Chapter Representatives Will Be Held on the Fifth Floor, Engineering Societies Building**

Under the sponsorship of the Society's Committee on Student Chapters, and managed by the Conference of Metropolitan Student Chapters, a general student conference will be held on the fifth floor of the Engineering Societies Building beginning at 3:00 p.m.

The program has been prepared by students and will include a brief address of welcome with a response, a short address by an officer of the Society, introduction of two topics, "The Young Engineer in Government Employ" and "The Young Engineer in Private Employ," by members of the Society, followed by student discussion on these topics.

The conference is to be concluded about 5:00 p.m., and will be followed by a light collation and smoker. All students, members, and others interested will be welcome.

Dinner, Reception, and Dance

WEDNESDAY—January 18, 1939—Evening

Hotel Waldorf-Astoria

COMMITTEE: EDWARD P. PALMER, *Chairman*, and E. A. PRENTIS

7:00 **Assembly**

7:45 **Dinner**

9:30 **Reception to the President and Honorary Members**

10:00 **Dancing**

This function will be held in the Grand Ball Room of the Hotel Waldorf-Astoria, Park Avenue and 50th Street.

Dinner will be served promptly at 7:45 p.m.

Arrangements have been made for tables seating ten persons, and members may underwrite complete tables. Orders to underwrite a table must be accompanied by check in full and a list of guests.

Tickets will be $5.00 each. Tickets for Juniors, for the dance only, will be $2.00 per couple.

The seating list for the dinner dance will close at 5:00 p.m., Tuesday, January 17, 1939. Those who purchase tickets after that hour will be assigned to tables in the order of purchase. Tickets will be on sale at Society Headquarters until 5:00 p.m., Wednesday, January 18, 1939.

Sessions of Technical Divisions Occupy Entire Day

THURSDAY—January 19, 1939—Morning

CITY PLANNING DIVISION

Harold M. Lewis, *Chairman, Executive Committee, Presiding*

IMPROVEMENT OF NEIGHBORHOODS THROUGH REZONING

10:00 **Zoning and Other Protective Standards of the Federal Housing Administration**

Seward H. Mott, *Chief, Land Planning Section, Technical Division, Federal Housing Administration,* Washington, D.C.

10:30 **Protection of Vicinity of New York World's Fair Site by Rezoning**

Charles U. Powell, *M. Am. Soc. C.E., Engineer in Charge, Topographical Bureau, Borough of Queens,* Long Island City, N.Y.

11:00 **Progress and Trends in Strengthening the Zoning of Residential Areas in New York City**

Lawrence M. Orton, *Commissioner, City Planning Commission,* New York, N.Y.

ENGINEERING ECONOMICS DIVISION

Frederick H. McDonald, *Chairman, Executive Committee, Presiding*

SYMPOSIUM ON PUBLIC WORKS AND UNEMPLOYMENT RELIEF AS PERMANENT PUBLIC PROBLEMS

10:00 (1) **Lessons from Emergency Unemployment Relief**

Robert L. MacDougall, *Assoc. M. Am. Soc. C.E., Assistant Administrator and State Engineer, Works Progress Administration of Georgia,* Atlanta, Ga.

(2) **Lessons from Emergency Public Works Construction**

Stanley H. Wright, *M. Am. Soc. C.E., Regional Engineer, Federal Emergency Public Works Administration,* Altanta, Ga.

(3) **Toward a National Relief and Public Works Policy**

Frederick H. McDonald, *M. Am. Soc. C.E., Consulting Engineer; Chairman, Board of Consultants, Community and Industrial Research Institute,* Atlanta, Ga.

General Discussion

SANITARY ENGINEERING DIVISION

H. W. Streeter, *Chairman, Executive Committee, Presiding*

10:00 **Presentation of Reports of Division Committees**

(1) **Committee on Water Supply Engineering**

Thomas H. Wiggin, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y., *Chairman.*

(2) **Committee on Water Purification Research and Plant Design**

Joseph W. Ellms, *M. Am. Soc. C.E., Commissioner of Sewage Disposal, Department of Public Utilities,* Cleveland, Ohio, *Chairman.*

(3) **Committee on Technical Aspects of Refuse Disposal**

Harrison P. Eddy, Jr., *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass., *Chairman.*

(4) **Progress Reports of Other Committees**

General Discussion

STRUCTURAL DIVISION

A. H. Fuller, *Chairman, Executive Committee, Presiding*

9:30 **Brief Reports from Various Committees**

Progress Report of Committee on Wind Bracing

C. R. Young, *M. Am. Soc. C.E., Professor, Civil Engineering, University of Toronto,* Toronto, Ont., Canada, *Chairman.*

Report of Subcommittee on Experimental and Theoretical Investigation of Torsional Effects of Wind on Unsymmetrical Buildings

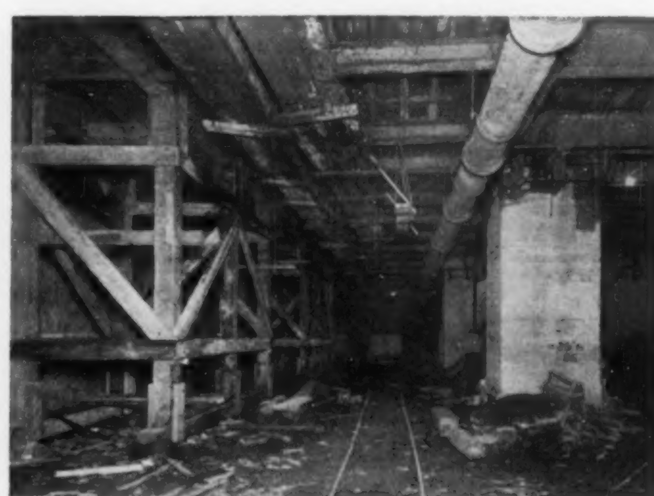
G. E. Large, *Assoc. M. Am. Soc. C.E., Associate Professor, Civil Engineering, Ohio State University,* Columbus, Ohio.

Report of Subcommittee on Simplified Method Involving the Use of K-Percentages

Francis P. Witmer, *M. Am. Soc. C.E., Director, Civil Engineering, University of Pennsylvania,* Philadelphia, Pa.

General Discussion

Queens-Midtown Tunnel Construction



Sixth Avenue Subway Cut Between 34th and 35th Streets

Scenes of Saturday Inspection Trips

Sessions of Technical Divisions (*Continued*)

THURSDAY—January 19, 1939—Afternoon

HIGHWAY DIVISION

L. G. HOLLERAN, *Chairman, Executive Committee, Presiding*

2:30 Effects of Flood and Hurricane on Connecticut Highways

WILLIAM J. COX, *M. Am. Soc. C.E., State Highway Commissioner, State Highway Department*, New Haven, Conn.

3:00 Comprehensive System of Main Thoroughfares for New York City and Vicinity

ROBERT MOSES, *Commissioner of Parks, City of New York*, New York, N.Y.

3:30 General Discussion

STRUCTURAL DIVISION

A. H. FULLER, *Chairman, Executive Committee, Presiding*

2:30 Brief Report of the American Committee Concerning the 1940 Congress of International Association for Bridge and Structural Engineering at Warsaw, Poland

ROBERT H. SHERLOCK, *M. Am. Soc. C.E., Professor, Civil Engineering, University of Michigan*, Ann Arbor, Mich.

Tension Tests of Large Riveted Joints

R. E. DAVIS, *M. Am. Soc. C.E., Consulting Engineer; Professor, Civil Engineering, University of California*, Berkeley, Calif.

GLENN B. WOODRUFF, *M. Am. Soc. C.E., Engineer of Design, San Francisco–Oakland Bay Bridge*, San Francisco, Calif.

HARMER E. DAVIS, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, University of California*, Berkeley, Calif.

Discussion opened by

W. M. WILSON, *M. Am. Soc. C.E., Research Professor, Structural Engineering, University of Illinois*, Urbana, Ill.

C. F. GOODRICH, *M. Am. Soc. C.E., Chief Engineer, American Bridge Company*, Pittsburgh, Pa.

JONATHAN JONES, *M. Am. Soc. C.E., Chief Engineer, Fabricated Steel Construction, Bethlehem Steel Company*, Bethlehem, Pa.

L. S. MOISSEIFF, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

General Discussion

SANITARY ENGINEERING DIVISION

H. W. STREETER, *Chairman, Executive Committee, Presiding*

2:30 Engineering Aspects of Milk Sanitation

LESLIE C. FRANK, *Senior Sanitary Engineer, U. S. Public Health Service*, Washington, D.C.

3:00 Discussion opened by

WALTER D. TIEDEMAN, *Principal Sanitary Engineer, State Department of Health*, Albany, N.Y.

3:30 Problems and Trends in Activated Sludge Practice

ROBERT T. REGESTER, *Assoc. M. Am. Soc. C.E., Consulting Engineer*, Baltimore, Md.

4:00 Discussion opened by

L. C. WHITTEMORE, *M. Am. Soc. C.E., Engineer of Design, The Sanitary District of Chicago*, Chicago, Ill.

WATERWAYS DIVISION

WILLIAM G. ATWOOD, *Chairman, Executive Committee, Presiding*

2:30 Behavior of Various Forms of Beach Protection Structures in the Recent Hurricane

(1) Long Island Structures

C. L. HALL, *M. Am. Soc. C.E., Colonel, Corps of Engineers, U.S.A., U. S. District Engineer*, New York, N.Y.

(2) New England Structures

RICHARD K. HALE, *Assoc. M. Am. Soc. C.E., Associate Commissioner, State Department of Public Works*, Boston, Mass.

An Analysis of Sediment Transportation in the Light of Fluid Turbulence

HUNTER ROUSE, *Assoc. M. Am. Soc. C.E., Associate Hydraulic Engineer, Soil Conservation Service, U. S. Department of Agriculture, California Institute of Technology*, Pasadena, Calif.

Discussion

LINING OPERATIONS, LINCOLN TUNNEL

PIERS AND ANCHORAGE, BRONX-WHITESTONE BRIDGE

Entertainment for the Ladies—Smoker for the Men

THURSDAY—January 19, 1939

Afternoon and Evening

FASHION SHOW, TEA, AND ENTERTAINMENT

Committee: E. Warren Bowden, *Chairman*, R. R. Graham, Chester L. Dalzell, Franklyn C. Rogers, and Woodman F. Scantlebury

3:00 **Fashion Show and Tea**

For the entertainment of the ladies, Bonwit Teller will present a fashion show at the Belvedere Ball Room, Hotel Astor. Known as "A Tonic Session on Clothes and Self-Discovery," a unique type of dramatized fashion talk and fashion show, originated by Bonwit Teller under the guidance of Mrs. Hortense M. Odlum, President, will be presented. A special feature of this show will be "Suggested Wardrobe for the World's Fair" as well as clothes for immediate wear and travel in the South.

Tea will be served following the show. Music will be furnished by an orchestra.

7:45 **Illustrated Address by Capt. John D. Craig, Explorer, Deep-Sea Diver, and Producer of Thrill Motion Pictures**

Seats have been reserved for ladies in the balcony of the Main Ball Room of the Hotel Astor for the Address and Motion Pictures by Capt. John D. Craig.

Following the Address refreshments will be served.

Attendance will be limited to 200 ladies. Tickets to ladies for the Address are $1.25 each.

Bridge Party at Engineering Woman's Club

For those who would prefer a different type of entertainment, a bridge party will be given at the Engineering Woman's Club, 126 East 35th Street. Attendance will be limited to 100 ladies. Tickets for the bridge party are $1.25 each.

Evening

SMOKER AND ENTERTAINMENT

Committee: Robert W. Sawyer, 3d, *Chairman*, Howard L. King, E. L. Macdonald, Vincent R. Cartelli, George L. Curtis, George G. Hayden, Sidney M. Marks, and George J. Viertel

Place, Hotel Astor—Time, 8:00 p.m. sharp

Entertainment—"Danger Is My Business," a thrilling and absorbing collection of unusual motion pictures.

The popular demand has been so overwhelming that we have persuaded Capt. John D. Craig to show us his films as proof of the tall stories he has told us. Captain Craig is coming from his present expedition off the northern coast of the Dominican Republic with under-water pictures in color of two coral-encrusted Spanish galleons wrecked in a hurricane more than 300 years ago. Huge coral formations make the work of diving akin to mountain climbing under water which is as clear as air.

You will see pictures taken while fighting big game fish, including the Manta-Ray, sharks, and an octopus as well as wrestling with swordfish—the pictures prove that this sport can be diverting to say the least. In contrast to the big fellows there are the fairy fish—some are extremely rare, others invisible; there are dancing starfish, fish who fish, and aeroplane fish (they warm up before taking off).

Come and see what happens when you are sent into Africa to get a full-face close-up picture of a lion.

Then, in a more serious vein, Captain Craig will present pictures of the helium-oxygen self-contained diving gear, showing original test and development work, first actual use of the gear for test purposes, and the first practical application of the equipment.

At the conclusion of the pictures we will enjoy music, smokes, and plenty of refreshments well mixed with good fellowship.

Tickets for the Smoker and evening's entertainment are free to members. Guest tickets are $3.00 each.

View of Construction Work, New York World's Fair; General Motors Building in Foreground

ALLENTOWN PLANT, MACK MANUFACTURING COMPANY

Friday Trip to Mack Manufacturing Plant, Allentown, Pa.

FRIDAY—January 20, 1939—All Day

COMMITTEE: GLENN S. REEVES, *Chairman*, WALDO G. BOWMAN, R. R. NACE, EUGENE QUIRICONI, and ALAN LEE SLATON

9:00 Special Train Leaves Jersey City Station of Central Railroad of New Jersey

Members, ladies, and guests will leave the Jersey City Station of the Central Railroad of New Jersey at 9:00 a.m. on a special train for the plant of the Mack Manufacturing Company at Allentown, Pa. The Jersey City Station of the Central Railroad of New Jersey may be most easily reached from Manhattan via ferries from Liberty Street. The last ferry to connect with the special train will leave Liberty Street at 8:45 a.m. The Liberty Street ferry station may be reached by the West Side Interborough Subway or the B.M.T. Subway to Cortlandt Street, or by the Eighth Avenue Subway to Hudson Terminal, thence walking west to the Ferry Terminal on the Hudson River. A box luncheon will be provided by the Mack Company. Returning, the train will leave Allentown at 3:30 p.m. assuring arrival in New York City by 6:00 p.m.

The excursion offers an opportunity to learn in detail how Mack trucks and buses, long familiar to engineers and construction men, are made. Mack motor vehicles are a product of the oldest commercial vehicle builder in the United States and the largest specialist in the heavy-duty types in the world. For the past 40 years the Mack Manufacturing Company and its predecessors have specialized in trucks of large capacity. In recent years the Mack line has been expanded to include light models, all of which may be seen in the process of manufacture and assembly at Allentown.

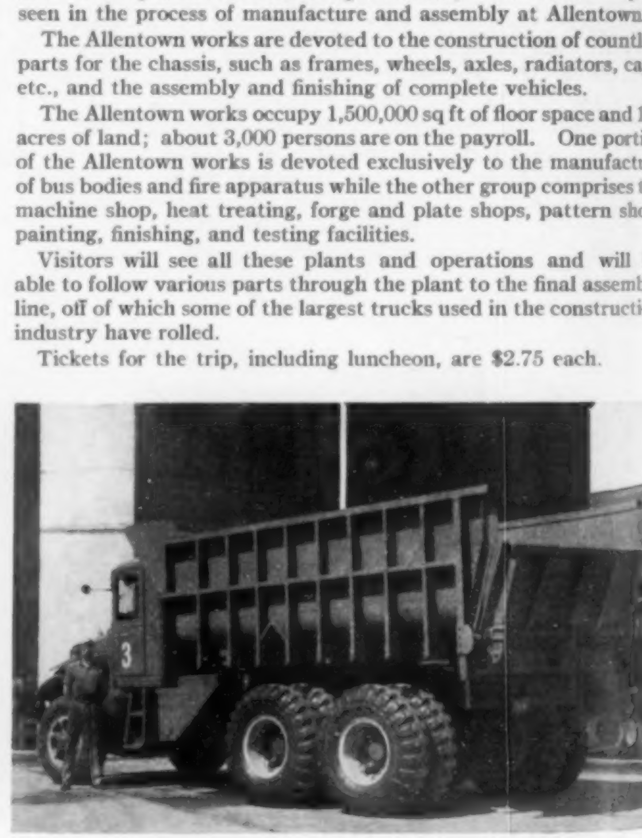
The Allentown works are devoted to the construction of countless parts for the chassis, such as frames, wheels, axles, radiators, caps, etc., and the assembly and finishing of complete vehicles.

The Allentown works occupy 1,500,000 sq ft of floor space and 150 acres of land; about 3,000 persons are on the payroll. One portion of the Allentown works is devoted exclusively to the manufacture of bus bodies and fire apparatus while the other group comprises the machine shop, heat treating, forge and plate shops, pattern shop, painting, finishing, and testing facilities.

Visitors will see all these plants and operations and will be able to follow various parts through the plant to the final assembly line, off of which some of the largest trucks used in the construction industry have rolled.

Tickets for the trip, including luncheon, are $2.75 each.

ASSEMBLY LINE SHOWING ENGINE INSTALLATION



FINISHED PRODUCT—A $57^1/_2$-TON TRUCK

College Reunions Throughout the Week

THURSDAY—January 19, 1939

Brown Engineering Association

The Brown Engineering Association will hold its Twenty-fifth Annual Dinner Meeting at the Midston House, corner Madison Ave. and 38th St., on Thursday, January 19, 1939. Reception at 6:00 p.m.; dinner at 6:30 p.m. Dr. Henry M. Wriston, President of the University, will be the principal speaker. Dr. Harvey N. Davis, President of Stevens Institute, will act as toastmaster. All Brown alumni or friends are invited. The charge will be $1.25 per cover. Make reservations through W. T. Breckenridge, Bell Telephone Laboratories, Tel. Chelsea 3-1000.

Luncheon of Chi Epsilon Honorary Civil Engineering Fraternity

Members of Chi Epsilon, their families and their friends, are again extended a cordial invitation to attend a very informal luncheon at the Midston House, 22 East 38th St., on Thursday, Jan. 19, 1939, at 1:15 p.m. Notify R. I. Land, 100 East 42nd St. (Ashland 4-3300, Ext. 194), or H. T. Larsen, Room 1607, 33 West 39th St. (Pennsylvania 6-9220, Ext. 87). The charge will be 90 cents per person.

Dinner of Cornell Society of Engineers

A dinner of the Cornell Society will be held on Thursday, January 19, 1939, at 6:30 p.m., at the Cornell Club, 107 East 48th St. In order to permit attendance at the Society Smoker at 8:00 p.m., no speaking arrangements have been made.

Iowa State College Alumni Meeting

Friends of Dean Marston and Dean Agg are invited to meet with the Iowa State College group at the Martinique Hotel, Broadway at 32d St., on Thursday Jan. 19, 6:45 p.m. This is a general meeting of the New York Iowa State group and is called for the purpose of honoring Dean Marston on receiving his Honorary Membership in the Society. The charge will be $2.00 per cover.

Lafayette College Civil Engineers' Dinner

All civil engineers of Lafayette College are invited to attend an informal dinner on Thursday, January 19, 1939, at 6:00 p.m., at Leeds Restaurant (Grill Room), 17 West 42nd Street (between Fifth and Sixth Aves.). If possible, come at 5:30 p.m. The charge will be $1.25 per cover. Please notify William R. Wolff, 156 Waverly Place.

Lehigh Engineers' Dinner

Lehigh members are cordially invited to attend a dinner of the New York Lehigh Club, on Thursday, January 19, 1939. Place of dinner announced later. The guest speaker has not been announced. Last year we had our fellow alumnus, Tom Girdler. This year it is the intention to have another speaker as well known as Tom. If you can come, notify Alexander Potter, 50 Church St.

Luncheon of M.I.T. Engineers

All M.I.T. alumni are invited to a luncheon at the Technology Club of New York, on Thursday, January 19, 1939, at 12:30 p.m., at the club rooms, 22 East 38th St. Please notify the Technology Club (Caledonia 5-1475) as to attendance.

Rutgers University Civil Engineers' Dinner

Rutgers University civil engineering alumni will meet for their annual dinner at 6:00 p.m., on Thursday, Jan. 19, 1939, at the Lawrence Coffee House, 28 West 39th St. The charge will be $1.00 per cover. Send checks to C. H. Gronquist, Room 1104, 117 Liberty St.

Syracuse University Alumni Dinner

Graduates and former students of the College of Applied Science of Syracuse University will hold a dinner at the Hotel Wentworth, 59 West 46th St., at 6:30 p.m., on Thursday, Jan. 19, 1939. Reservations at $1.50 per plate may be secured by writing S. F. Yasines, New York University, University Heights.

University of Illinois Engineers' Dinner

All University of Illinois engineers and their friends are invited to the Eleventh Annual Informal Dinner-Reunion at the Hotel Woodstock, 127 West 43rd St., on Thursday, Jan. 19, 1939, at 5:45 p.m., in the grill adjoining the main lounge. The dinner will cost $1.25 and will be over in time to attend the Society's Smoker. Please notify Alfred Hedefine, 142 Maiden Lane (John 4-2150).

University of Michigan

The University of Michigan Club of New York has tentatively set its January meeting to coincide with the Society's Annual Meeting. Definite information may be obtained by calling Beach Conger, '32, Secretary-Treasurer, at Caledonia 5-1380.

University of Pennsylvania Civil Engineers' Dinner

The Twentieth Annual Informal Dinner of the University of Pennsylvania Civil Engineers will be held at the University of Pennsylvania Club, 22 East 38th St., on Thursday, Jan. 19, 1939, from 6:00 to 7:00 p.m. The dinner fills in the time from the end of the technical session at 5:00 p.m. until the commencement of the Smoker at 8:00 p.m. Dinner will be served at 6:00 p.m. sharp, in the main dining room of the club.

The charge per cover will be $1.25. Any further information can be obtained from Albert B. Hager, care, Atlantic, Gulf and Pacific Company, 15 Park Row.

FRIDAY—January 20, 1939

Dinner of Columbia Engineers

The graduates of Columbia University who are members of the Society will meet for their eighteenth informal dinner on Friday, Jan. 20, 1939, at 6:30 p.m., at the Columbia University Club, 4 West 43rd St. The guest of honor will be Enoch R. Needles, M. Am. Soc. C.E., Consulting Bridge Engineer, who will speak on "Professional Relationships of the Engineer." The charge will be $1.75 per cover. Address communications to J. K. Finch, Columbia University.

Harvard-Yale-Princeton Annual Huddle

The Harvard-Yale-Princeton Annual Huddle will be held on Friday evening, January 20, 1939.

The subject and locale of the meeting will be New York World's Fair 1939, and as a departure from previous years the entire afternoon and part of the evening will be devoted to the affair. All members and their families are requested to gather at the Administration Building on the Fair grounds, where transportation will be provided for an inspection of the grounds and buildings.

At 6 o'clock all present will gather in the cafeteria for a buffet supper, following which remarks will be made by S. F. Voorhees of Princeton, chief of the board of design, Col. John P. Hogan of Harvard, chief engineer, and others, who will explain the architectural and engineering aspects of this great project. An inspection of the Board of Design Department, with its models and drawings, will complete the evening.

New York University Annual Alumni Reunion Dinner

The Annual Reunion Dinner for the alumni of New York University will be held at the Midston House, 22 East 38th St., on Friday, Jan. 20, 1939, at 7:00 p.m. Come at 6:30 p.m. and enjoy a social period before dinner. Send reservations to K. K. Murdichian, 458—77th Street, Brooklyn, N.Y. Dinner will cost $1.50.

Thayer Society of Engineers of Dartmouth College

The annual meeting and dinner of the Thayer Society of Engineers of Dartmouth College will be held at the Dartmouth College Club, 30 East 37th St., at 6:30 p.m., on Friday, Jan. 20, 1939. Notify the Dartmouth College Club as to attendance.

SATURDAY—January 21, 1939

Clarkson College Alumni Dinner

The annual dinner of the Clarkson College Alumni Association will be held at the Building Trades Employers' Association Club, 26th Floor, 2 Park Ave., on Saturday, Jan. 21, 1939, at 6:30 p.m. There will also be an informal lunch and an afternoon meeting on the same day in the same place. Notify Frank C. Boes, 38 Cypress Street, Floral Park, N.Y., as to attendance.

Trips to Points of Engineering Interest

SATURDAY—January 21, 1939—Morning

10:00 Inspection Trips

Arrangements have been made for visits to the following points of interest:

1. **Sixth Avenue Subway Construction**
2. **Queens Midtown Tunnel**
3. **Lincoln Tunnel**
4. **U. S. Navy Yard**
5. **New York World's Fair Site**
6. **Red Hook Housing Project, Brooklyn**

As all the above trips start at the same hour, it will not be possible to participate in more than one. Members will proceed individually to the rendezvous point named for the trip that is selected, so as to arrive at the time given.

Attention of sanitary engineers is directed to the announcement elsewhere in the program of the inspection of the Tallman Island Sewage Treatment Plant that has been arranged by the New York State Sewage Works Association and the Sanitary Engineering Division.

SIXTH AVENUE SUBWAY CONSTRUCTION

The Sixth Avenue Subway is a link in the Independent City-Owned Rapid Transit Railroad, connecting existing tracks at Ninth Street with those at 53rd Street. The subway is a 4-track structure north of 33rd Street, and in the initial construction a 2-track structure south of 33rd Street. The work is divided into six construction contracts, having an aggregate cost of about $39,000,000, and is the most difficult subway construction that has been undertaken in the city.

Interesting construction is in progress at this time between 32nd and 35th Street, where inspection will be made of the underpinning of the elevated columns and buildings; construction of the subway structure under the existing B.M.T. Rapid Transit subway without interference with the operation of the railroad; decking and supports; subsurface structures; and the erection of steel, concreting, and waterproofing of the subway structure.

At 34th Street, the method of constructing the new subway under the existing B.M.T. structure should be of particular interest.

The party will meet for the inspection in the lobby of the Engineering Societies Building at 10:00 a.m. The trip may be expected to take not over two hours, and arrangements will be made for guides to pilot the party over the work in small groups.

QUEENS MIDTOWN TUNNEL UNDER EAST RIVER

Members taking this trip will go directly to the Field Office of the New York City Tunnel Authority, situated at 42nd Street and First Avenue.

Among the features of the trip will be an inspection of construction of the Manhattan Approach, including rock tunnel work, cut-and-cover construction, ventilation building and shaft, contractor's air compressing plant for the river tunnels, air locks, and tunnel bulkheads.

LINCOLN TUNNEL

The north tube of the Lincoln Tunnel was "holed through" on May 2, 1938. The contractor for the under-river portion, the Mason and Hanger Company, Inc., is now placing the concrete lining.

This lining is being placed in nine different sequences, the work starting with the invert slab and proceeding up to the roof of the tunnel, the ceiling slab being poured last. Each operation is started from the New York end and proceeds westward. At the present time all sequences are in process of construction. The invert has been placed all the way across the river and the floor slabs and lower air duct, about halfway across the river.

The party will enter the tunnel at 39th Street and 11th Avenue and can walk under the river to about the state line, thus enabling all the different processes of placing the concrete lining to be seen.

U. S. NAVY YARD

The Navy Yard may be reached via Flushing Avenue street cars taken at the New York end of the Brooklyn Bridge, thence to the Cumberland Street gate of the Navy Yard. In going to the Navy Yard by automobile, cross the Manhattan Bridge and turn left at the Brooklyn end, proceeding via Flushing Avenue to the Cumberland Street gate.

Of interest to civil engineers, there will be several large contracts under way, including an extension of the overhead crane runway structures over the building ways.

The extension of Dry Dock No. 4 will be in progress and probably some of the steel work for an extension of the Structural Shop will be under erection.

As to ships, there will probably be three destroyers at the Yard, one of which will be available for visitors. There will be opportunity to see, but not to go aboard, one of the recently launched cruisers.

On account of Navy Department regulations, only American citizens can be admitted to the Yard.

NEW YORK WORLD'S FAIR SITE

Through the courtesy of the officials of the New York World's Fair, Inc., members will be privileged to inspect the Fair grounds and buildings on Saturday forenoon, January 21, 1939. The scheme for the World's Fair was launched in the fall of 1935, when a non-profit corporation, the New York World's Fair 1939, Inc., was formed. The Fair will open in April 1939, the date commemorating the 150th anniversary of the inauguration at New York of George Washington as the first President of the United States.

To reclaim the $1{,}216^1/_2$-acre Fair tract and construct the buildings has been a stupendous accomplishment. Ground-breaking ceremonies were held on June 29, 1936, and by the end of March 1937 the grading and filling had been completed. This involved the leveling of ash heaps 80 to 90 ft high and the spreading of some 9,000,000 cu yd of ashes, over which topsoil has been placed.

When the Fair is opened, some $150,000,000 will have been invested in it, and the Fair tract will have been reclaimed and made ready for swift transformation into a municipal park after the Fair period. More than 60 nations are participating along with most of the states and possessions of the United States, and industry is represented on an unprecedented scale.

The Fair can be conveniently reached by means of Long Island Railroad trains, as follows:

GOING:			
Leave New York Pennsylvania Station.	9:07 a.m.	10:05 a.m.	
Arrive World's Fair	9:34 a.m.	10:22 a.m.	
RETURNING:			
Leave World's Fair	11:58 a.m.	12:29 p.m.	12:58 p.m.
Arrive New York, Pennsylvania Station .	12:14 p.m.	12:45 p.m.	1:14 p.m.

Guides will be provided to show the visitors around the grounds.

RED HOOK HOUSING PROJECT, BROOKLYN

The Red Hook Housing Project when completed will consist of 29 buildings, 25 of which will be used for dwelling purposes, two for stores, one as a nursery school, and another as a community center. In the 25 buildings to be used as dwellings, there will be 2,541 units, with 10,656 rentable rooms.

To make way for this project, 285 buildings were demolished. The cost of the completed project will be approximately $12,750,000 or $5,018 per dwelling unit.

The Red Hook project is adjacent to the Red Hook Park of some 40 acres, and may be reached via the Brooklyn Line of the Independent (Eighth Avenue) Subway to the Smith-9th Street Station.

General Announcements

SANITARY ENGINEERS' MEETINGS, DINNER, AND INSPECTION TRIP

THURSDAY—January 19, 1939—All Day

The Sanitary Engineering Division of the Society extends a cordial invitation to members of the New York State Sewage Works Association to attend the sessions of the Sanitary Engineering Division on Thursday.

Following the sessions, members of the two groups will hold a joint dinner at the Hotel McAlpin, Broadway and 34th Street, New York, N.Y.

Time, 6:00 p.m. Price of tickets, $2.50 each.

Following is the program of the Eleventh Annual Meeting of the New York State Sewage Works Association for Friday and Saturday, January 20 and 21, 1939, at the Hotel McAlpin, to which all members of the Sanitary Engineering Division are invited:

FRIDAY—January 20, 1939—All Day

8:30 **Registration**

10:00 **Business Meeting, Committee Reports, and Recording of Ballots for Election to Executive Committee**

11:30 **Legal Aspects of Stream Pollution**

James A. Tobey, *Ph.D., L.L.D., Director, Department of Nutrition, American Institute of Baking*, New York, N.Y.

12:15 **Luncheon and Presentation of Kenneth Allen Memorial Award**

2:30 **Sewer Rentals—Symposium**

Leaders: R. A. Allton, *M. Am. Soc. C.E., Consulting Engineer, Division of Sewage Treatment*, Columbus, Ohio.

R. C. Sweeney, *Assoc. M. Am. Soc. C.E., District Sanitary Engineer, Albany District, State Department of Health*, Albany, N.Y.

M. W. Tatlock, *Assoc. M. Am. Soc. C.E., Consulting Engineer*, Dayton, Ohio.

W. F. Tempest, *Highways and Municipal Bureau, Portland Cement Association*, Chicago, Ill.

4:30 **Features of the Tallman Island Sewage Treatment Works, New York City**

Henry Liebmann, *Designing Engineer*, and E. J. Fort, *M. Am. Soc. C.E., Project Engineer, Department of Sanitation, City of New York*, New York, N.Y.

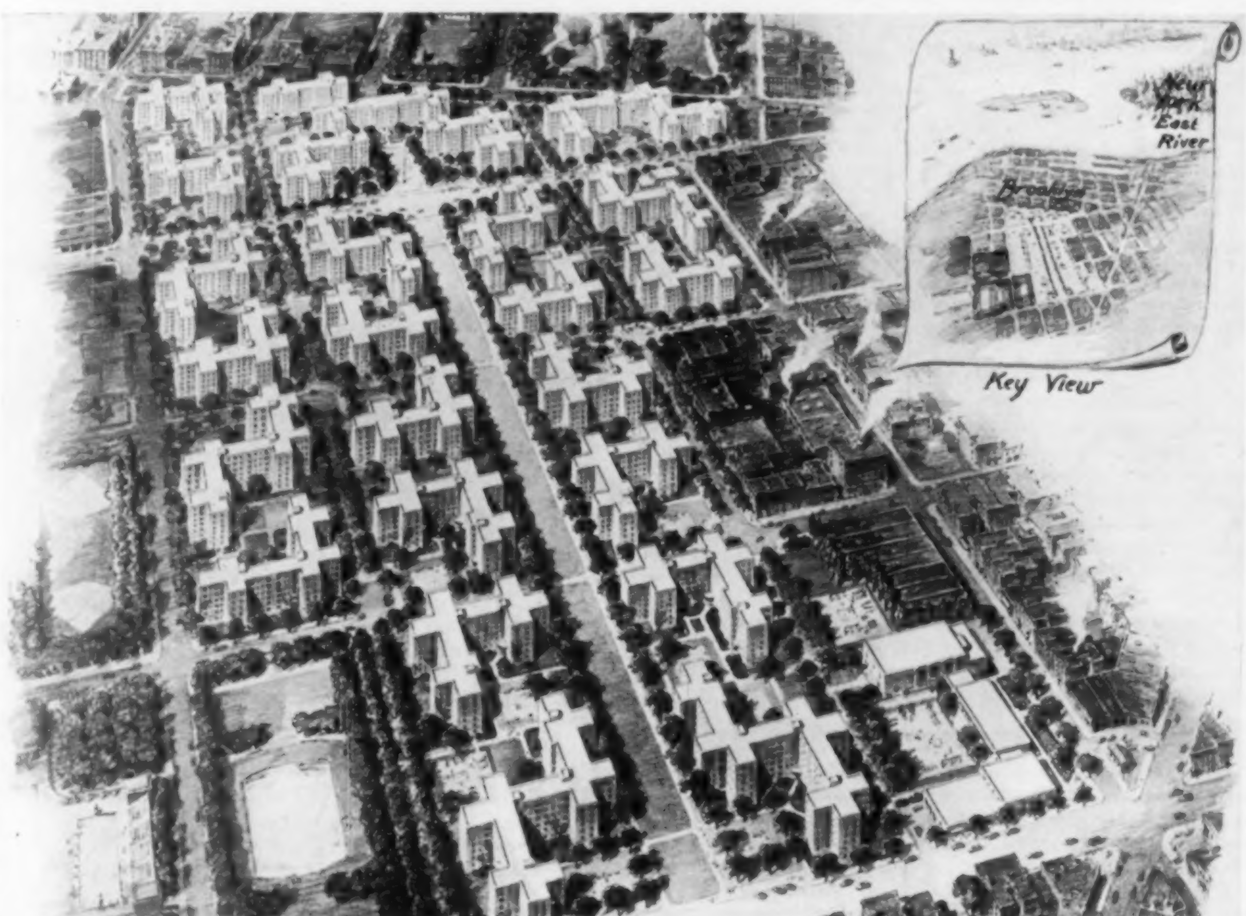
5:00 **Adjournment**

SATURDAY—January 21, 1939—Morning

9:00 Sharp—**Inspection Trip to Tallman Island Sewage Treatment Plant of New York City and Construction Features of World's Fair**

The party will leave the 34th Street entrance, Hotel McAlpin, by bus at 9:00 a.m. sharp for an inspection of the Tallman Island Sewage Treatment Plant and the World's Fair.

Reservations for the trip are to be made through William Raisch, 227 Fulton Street, New York, N.Y.



Red Hook Housing Project
Scene of One of the Saturday Inspection Trips

General Announcements (*Continued*)

Hotel Accommodations and General Announcements

Hotel Accommodations

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Annual Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in New York.

Hotel Rates

Hotels	Without Private Bath		With Private Bath	
	Single Room	Double Room	Single Room	Double Room
Waldorf-Astoria	.....	.....	$7.00 up	$10.00 up
Astor	.....	.....	3.50 up	6.00 up
Barclay	.....	.....	5.00 up	8.00 up
Biltmore	.....	.....	6.00 up	8.00 up
Chatham	.....	.....	5.00 up	7.00 up
Claridge	.....	.....	2.00 up	3.00 up
Commodore	.....	.....	3.50 up	5.00 up
Governor Clinton	.....	.....	3.00 up	4.00 up
Lexington	.....	.....	3.50 up	5.00 up
McAlpin	2.50 up	4.00 up	3.50 up	5.00 up
Murray Hill	2.00 up	3.00 up	2.50 up	4.00 up
New Yorker	.....	.....	3.50 up	5.00 up
Pennsylvania	.....	.....	3.50 up	5.00 up
Plaza	.....	.....	6.00 up	8.00 up
Roosevelt	.....	.....	5.00 up	7.00 up
Savoy-Plaza	.....	.....	6.00 up	8.00 up
Taft	.....	3.00 up	2.50 up	3.50 up
Vanderbilt	.....	.....	3.50 up	6.00 up
Woodward	.....	.....	2.50 up	3.50 up

NOTE: The Waldorf-Astoria, at which the reception, dinner, and dance will be held, will care for reservations to the extent of its capacity.

Special Hotel Accommodations

For the convenience of members, arrangements have been made with a number of hotels to furnish accommodations at daily rates which include breakfast, as follows:

Hotels	Single Room With Bath and Breakfast	Double Room With Bath and Breakfast (for 2)	Suite of 2 Rooms With Bath and Breakfast (for 2)
Hotel Albert	$2.50	$3.50	$ 5.00
Hotel Earle	2.50	3.50	5.00
Hotel Van Rensselaer	2.50	3.50	5.00
Hotel Holley	2.50	3.50	5.00
Hotel Wellington	3.00	4.50	6.00
Hotel Vanderbilt	4.25	6.50	11.50

Those interested in the above arrangement should communicate directly with the hotel concerned.

Facilities of Engineers' Club

For the convenience of out-of-town members, arrangements have been made for members to use the dining facilities of the Engineers' Club on a cash basis. Guest cards for this purpose may be obtained at the Registration Desk. The Club will also be able to accommodate a limited number of members, the price of rooms ranging from $2.50 upward. Requests for reservations should be made in advance and addressed to Society Headquarters.

Information Desk

An information desk is provided in the Reading Room of the Society on the fifteenth floor of the Engineering Societies Building to assist visiting members in obtaining hotel reservations and theater tickets, and in securing any desired information.

Your New York Address

At the Registration Desk a card file of those in attendance will be maintained, with information as to members' hotel addresses in New York. Members are requested to keep Headquarters informed as far as possible of their New York addresses so as to expedite the delivery of telegrams, telephone messages, and mail.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements. Ticket order blanks have been mailed to each member with the condensed program.

No cancellation of tickets can be made after noon of Wednesday, January 18, 1939.

Post-Meeting Trip to Bermuda

Members have already received notice of another trip to Bermuda following the Annual Meeting.

On Saturday, January 21, the party again will sail on the *Monarch of Bermuda*, famous for its equipment and appointments. The Hotel Bermudiana, overlooking the town and harbor of Hamilton, will be the headquarters.

The cruise includes a stop of three days, which may be extended if desired, and the prices include first-class round-trip transportation; room with meals on shipboard; room with bath and all meals at Bermuda; U. S. Government and Bermuda taxes; transfer of passengers and baggage from pier to Hotel Bermudiana; rail transportation from Hamilton to St. George; and transfer from St. George to the *Monarch of Bermuda* for the return.

Make your deposit and hold your cabin if there is a chance that you will go. You may cancel later if you must and your deposit will be returned.

Write to the Secretary, 33 West 39th Street, New York, N.Y., for full information.

Regional Meeting Committee

This program has been prepared under the direction of the Committee on Regional Meetings, Malcolm Pirnie, Vice-President, Am. Soc. C.E., Chairman; and James K. Finch, E. R. Needles, Carlton S. Proctor, and William J. Shea, Directors, Am. Soc. C.E.

Committee on Local Arrangements for the Annual Meeting

E. W. STEARNS, *Chairman*
ROBERT W. SAWYER, 3D, *Vice-Chairman*

E. WARREN BOWDEN
WALDO G. BOWMAN
C. W. BRYAN, JR.
R. R. GRAHAM
HOWARD L. KING
E. L. MACDONALD
R. R. NACE
EDWARD P. PALMER
E. A. PRENTIS
GLENN S. REEVES

Junior Members

VINCENT R. CARTELLI
GEORGE L. CURTIS
CHESTER L. DALZELL
GEORGE G. HAYDEN
SIDNEY M. MARKS
EUGENE QUIRICONI
FRANKLYN C. ROGERS
WOODMAN F. SCANTLEBURY
ALAN LEE SLATON
GEORGE J. VIERTEL

Ladies Committee

MRS. E. W. STEARNS, *Chairman*

MRS. E. WARREN BOWDEN
MRS. W. G. BOWMAN
MRS. C. W. BRYAN, JR.
MRS. J. K. FINCH
MRS. R. R. GRAHAM
MRS. OTIS E. HOVEY
MRS. HAROLD W. HUDSON
MRS. HOWARD L. KING
MRS. HAROLD M. LEWIS
MRS. E. L. MACDONALD
MRS. R. R. NACE
MRS. E. R. NEEDLES
MRS. GEORGE H. PEGRAM
MRS. MALCOLM PIRNIE
MRS. E. A. PRENTIS
MRS. CARLTON S. PROCTOR
MRS. GLENN S. REEVES
MRS. ROBERT RIDGWAY
MRS. ROBERT W. SAWYER, 3D
MRS. GEORGE T. SEABURY
MRS. WILLIAM J. SHEA
MRS. ARTHUR S. TUTTLE

Please call on the Committee on Local Arrangements or on the Secretary's Office for any service desired.

Don't Miss the Special Train Excursion on Friday—Assist the Committee by Registering Early for the Trip

SOCIETY AFFAIRS

Official and Semi-Official

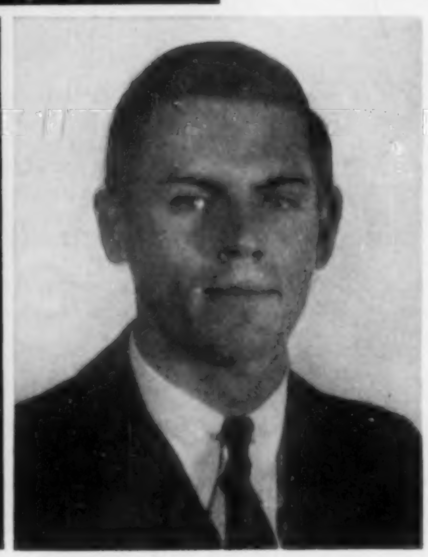
1938 Prize Winners and Medalists

HUNTER ROUSE
Norman Medal for Paper, "Modern Conceptions of the Mechanics of Fluid Turbulence"

ERNEST C. HARTMANN
J. James R. Croes Medal for Paper, "Structural Application of Aluminum Alloys"

LEON S. MOISSEIFF
James Laurie Prize for Paper, "Evolution of High-Strength Steels Used in Structural Engineering"

CHARLES M. NOBLE
Arthur M. Wellington Prize for Paper, "The Modern Express Highway"



DOUGLAS M. STEWART
Collingwood Prize for Juniors for Paper, "Behavior of Stationary Wire Ropes in Tension and Bending"

In accordance with its usual custom, the Society will present prizes and medals at its Annual Meeting, to be held in New York City, January 18–20, 1939. Of these Society awards the oldest is the Norman Medal, which was endowed in 1872 by the late George H. Norman, M. Am. Soc. C.E., for an original paper that is considered an especially distinguished contribution to the engineering profession.

Next in point of honor is the J. James R. Croes Medal, established by the Society in 1912 and named for the first recipient of the Norman Medal. This award is made for the paper considered second in merit to that receiving the Norman Medal. The James Laurie Prize was also established by the Society in 1912 and named in honor of its first President.

The Arthur M. Wellington Prize for the best paper on some phase of transportation was established and endowed by the *Engineering News-Record* in 1921. The award of this prize rests with the Society, although it is not required that the recipient be a member. In 1894 the Collingwood Prize for Juniors was established by the late Francis Collingwood, M. Am. Soc. C.E., on his retirement as Secretary of the Society. Papers eligible for this award must describe an engineering work or record an important investigation with which the author has been connected. Excellence of style is also a factor in the selection of the paper receiving this prize.

Biographical sketches of those receiving prizes or medals follow.

Hunter Rouse was born in Toledo, Ohio, on March 29, 1906. After graduating from Scott High School, Toledo, in 1924, he attended Toledo University in 1924 and 1925. He then served one year and two succeeding summers as rodman and instrumentman in the Lucas County Surveyors Office. In the fall of 1926 he entered the Massachusetts Institute of Technology as a sophomore. He edited the undergraduate newspaper and was elected

to the senior honorary society. In 1929 he received the S.B. degree from the department of civil engineering. He spent the next two years in Europe as Massachusetts Institute of Technology Traveling Fellow in Hydraulics, studying laboratory technique and conducting research for the engineering doctorate under Geheimrat Rehbock of Karlsruhe, Germany. He returned to the Massachusetts Institute of Technology as assistant in hydraulics, teaching undergraduate courses and serving on the staff of the River Hydraulics Laboratory. He received the degree of S.M. in C.E. in 1932, and the following summer passed an examination in Karlsruhe for the degree of Doktor-Ingenieur. In 1933 Dr. Rouse became instructor in civil engineering at Columbia University, and for two and a half years assisted Prof. B. A. Bakhmeteff in the development of a research laboratory for fluid mechanics. He joined the staff of the Cooperative Laboratory of the Soil Conservation Service and the California Institute of Technology in 1936, also becoming assistant professor of fluid mechanics at the Institute. During the past summer he revisited European hydraulic laboratories, returning by way of Cambridge to take part in the Fifth International Congress for Applied Mechanics. At present Dr. Rouse is engaged in research on sediment transportation and allied hydraulic subjects, and is lecturing on advanced hydraulics and fluid mechanics. He is a member of Sigma Chi, Tau Beta Pi, Chi Epsilon, and Sigma Xi fraternities. Dr. Rouse is the author of a dozen or more papers on hydraulic research, and of the Engineering Societies Monograph, "Fluid Mechanics for Hydraulic Engineers."

ERNEST C. HARTMANN, Assoc. M. Am. Soc. C.E., was born on June 22, 1903, in Decatur, Ill., where he received his early schooling, including two years at James Millikin University. In 1924 he was graduated from the University of Illinois, receiving the degree of bachelor of science in civil engineering. Immediately following graduation, he was employed for a short time as draftsman by the Mississippi Valley Structural Steel Company and, later the same year, was engaged by the Illinois Central Railroad to assist in the design of the overhead structures for the Chicago electrification project. In 1925 he was appointed a research graduate assistant at the Engineering Experiment Station at the University of Illinois. For the two years of this appointment his work was principally concerned with tests of large and small rollers under the direction of Prof. Wilbur M. Wilson. In 1927 Mr. Hartmann received the degree of master of science in civil engineering and entered the employ of Waddell and Hardesty, consulting bridge engineers of New York City. In 1929 he became a research engineer for the Aluminum Company of America at their research laboratories in New Kensington, Pa. During the past ten years he has been in charge of the research program on structural aluminum under the direction of R. L. Templin, chief engineer of tests. Mr. Hartmann is a member of Tau Beta Pi, Chi Epsilon, Sigma Xi, Theta Tau, Phi Kappa Phi, and is the author and co-author of a number of articles dealing with structural aluminum.

LEON S. MOISSEIFF, M. Am. Soc. C.E., was born in Riga, Latvia, on November 10, 1872. After studying at Alexander Gymnasium and Baltic Polytechnicum, he graduated from Columbia University in 1895 with the degree of civil engineering. His professional career has been connected chiefly with the design and construction of bridges. From 1897 to 1915 he was bridge engineer and engineer of design for the Department of Bridges, City of New York. During that period he was employed on the design of the Queensboro and Manhattan bridges, the strengthening of the Williamsburgh Bridge, and the proposed Hudson Memorial Bridge. Since 1915 he has maintained a consulting practice, specializing in bridges and structures. He was engineer of design on the Delaware River Bridge, at Philadelphia; and consulting engineer on the Ambassador Bridge, at Detroit, and the high-level suspension bridge at Toledo. Mr. Moisseiff also served as consulting engineer on the George Washington Bridge, the Bayonne (Kill van Kull) Arch, the Triborough Bridge, the East River bridges (New York), and the Chicago World's Fair, and he was a member of the consulting board of the Golden Gate Bridge and the San Francisco–Oakland Bay Bridge. From 1929 to 1932 he was consulting engineer to the Commissariat of Transportation, U.S.S.R. At present he is engaged as consulting engineer on the Whitestone Bridge, New York; the Tacoma Narrows Bridge, Washington; and the Mackinac Strait Bridge, Michigan. He developed the deflection theory of suspension bridges and was the first to introduce it into actual bridge design. He also established theories of the action of lateral forces on suspension bridges, on which modern suspension bridge design is based. The author of numerous technical papers, Mr. Moisseiff received the Franklin Institute's gold medal in 1933 for a paper on the Bayonne Arch and the Society's Norman Medal in 1934 for his paper on the George Washington Bridge. He is a member of numerous engineering societies and committees, including the Joint Committee on Concrete and Reinforced Concrete. He is a director of the American Welding Society and is chairman of its Structural Steel Welding Committee. He is also a member of Sigma Xi.

CHARLES M. NOBLE, M. Am. Soc. C.E., was born at Bushnell, Fla., on June 10, 1896. His training was obtained in special courses at Columbia University and in the office of Alfred F. Harley, consulting engineer of Jacksonville, Fla. During the war Mr. Noble served overseas in the U. S. Naval Reserve Force. Upon his return to this country he engaged in highway engineering work—in 1920 as acting resident engineer for the Alabama State Highway Department; from 1921 to 1923 as locating engineer and resident engineer for the Kentucky State Highway Department; and from 1923 to 1925 as resident highway engineer for the New Jersey State Highway Department. In the latter year Mr. Noble became connected with the Port of New York Authority, where he remained until September 1938. During this period he served as an engineer engaged on the design of numerous projects, including the Outerbridge Crossing, the Goethals Bridge, the Bayonne Bridge, the George Washington Bridge, and the Lincoln Tunnel. At present he is on the engineering staff of the Pennsylvania Turnpike Commission, engaged on the construction of a toll express highway between Harrisburg and Pittsburgh. Mr. Noble is the author of various works on express highway design and, for the past two years, has been visiting lecturer on this subject before the graduate school at Harvard University. He is also special lecturer on the safe design of highway structures for various technical societies and civic groups. In 1938 Mr. Noble was awarded the Clemens Herschel Prize of the Boston Society of Civil Engineers for his paper entitled "The Factor of Safety in Highway Design," presented at the January 1937 meeting of the Boston Society of Civil Engineers and published in the April 1937 Journal of this organization. He was also a joint recipient of honorable mention in an international competition for the design of an elevated express highway.

DOUGLAS MACMILLAN STEWART, Jun. Am. Soc. C.E., was born in Newport, R.I., on May 4, 1912, and passed his early years at army posts in various parts of the world. He entered Brown University, where he was graduated with the A.B. degree in 1931. He then entered Massachusetts Institute of Technology and received the degree of B.S. in civil engineering in 1933. Awarded the Garrett Linderman Hoppes Research Fellowship at Lehigh University, he studied there and received the degree of M.S. in civil engineering in 1935. While working at the Fritz Laboratory in Lehigh University, under the direction of Prof. Inge Lyse and with the cooperation of the Wickwire-Spencer Steel Company, he gathered the information on wire ropes contained in the paper for which he was awarded the Collingwood Prize Since 1935 Mr. Stewart has been employed by the Ingersoll-Rand Company, and is at present an engineer in their Turbo-Blower Department in New York City. He is a member of Phi Beta Kappa, Sigma Xi, Tau Beta Pi, Chi Epsilon, and Phi Gamma Delta fraternities.

"Trim Size" of CIVIL ENGINEERING Changed

WITH this issue, the "trim size" of CIVIL ENGINEERING changes from 9 by 12 in. to $8^3/_4$ by $11^5/_8$ in. Change to this so-called "standard" size is simultaneously being made by a number of other technical journals as well. The resulting uniformity is of particular importance to advertisers, who supply their copy in the form of electrotypes. Incidentally, in the case of CIVIL ENGINEERING, an appreciable saving in paper costs will be effected.

Appointments of Society Representatives

JOHN W. ALVORD, Hon. M. Am. Soc. C.E., has been appointed a Society representative on the Board of Award of the recently established Anson Marston Medal.

F. J. CELLARIUS, M. Am. Soc. C.E., was appointed to represent the Society at the inauguration of the Rev. John A. Elbert, as president of the University of Dayton, on December 3.

New Elections to Honorary Membership

Brief Biographies of Notable Engineers Who Will Receive Signal Distinction at the Society's Forthcoming Annual Meeting

C. FRANK ALLEN

To few engineers is it given to devote so long and so profitable a lifetime to a single community as C. Frank Allen has given to Boston and its environs. It is true that somewhat over ten years during his young manhood were spent in the Southwest, but otherwise his entire lifetime—and he is now 87—has centered about its present locale.

C. Frank Allen

From the Boston schools he went into the Massachusetts Institute of Technology just after its first class had been graduated in 1868. He was one of three men who received the S.B. degree in civil engineering in 1872. His stimulating contacts with such men as Prof. J. B. Henck and President William Barton Rogers, founder of the Institute, undoubtedly exerted a marked influence on his professional life. For a few years he stayed in New England, engaged on water supply and sewerage works in Providence and Boston. In this work he was fortunate to be associated with the late Howard A. Carson, Honorary Member of the Society, who later became chief engineer of the first subways of Boston.

In 1878 he answered the call of the West and the romance of railroad engineering work. This field became one of his major interests throughout a long career. It also led to another coordinate field which he developed to marked advantage, for his work in the office of the chief engineer of the Santa Fe Railroad brought him into frequent contact with the law department and thus a latent capacity for legal matters was stimulated. He studied law, and shortly, in 1885, was admitted to the bar in New Mexico; later likewise in Massachusetts, in 1901. While he was in the Southwest he served as local attorney for the railroad company, also for a time as city attorney at Socorro, N. Mex., and for a year as chief engineer of the water works at Las Vegas.

No one who has heard Professor Allen speak of his experiences during this period can fail to recognize how much it meant to him. Aside from his start in the legal profession, it gave him close contacts with some very practical aspects of engineering. He gained a great respect for the old-fashioned engineer, long in common sense although perhaps short in theory, the remarkable product of a rigorous but effective self education. Doubtless these early hardships were good for him, although he confesses that the romance of the Wild West has been somewhat overplayed.

Another great advantage of this work, to a developing young engineer, was its training in getting along with people. He soon found the advantage of tolerance and broad-mindedness, of recognizing true value beneath a rather forbidding surface. This particular phase of his experience was of great service to him in his later career.

In 1887, his father's death caused a change in all his plans. Although the Rio Grande country held much fascination for him—the future Mrs. Allen was the daughter of the first president of the New Mexico College of Agriculture and Mechanic Arts—nevertheless he returned East. Shortly he was invited by George F. Swain, later President and Honorary Member of the Society, to enter the civil engineering department of the Massachusetts Institute of Technology and take charge of the work in railroad engineering. At once he was successful; he became associate professor two years later and professor in less than ten years, a position he held for twenty years more. In 1916 he retired, or at least as much as such an active spirit can ever retire. Meanwhile he had published his well-known *Railroad Curves and Earthwork*, followed a few years later by a companion volume, *Field and Office Tables.* Still later, after retirement, he issued his *Business Law for Engineers*, which is similarly well known in the profession.

Everything that has as its aim the furtherance of his profession has always held the interest of Professor Allen. He served as president and is now honorary member of the Boston Society of Civil Engineers. At times he has been president of the New England Railroad Club, and of the Massachusetts Highway Association. A lifetime of interest in teaching brought its recognition when he became president of the Society for the Promotion of Engineering Education. In the American Railway Engineering Association he is now a life member.

His memory of Society affairs, as of other matters, is unusually distinct. He recalls his first association in connection with the convention at New Orleans in 1877. This he attended with other members of the Boston Society of Civil Engineers, with the advantages of a special train and free passes. It is no wonder that the organization and its associations looked so attractive. His interest has never flagged, in spite of the fact that today he is with one exception the oldest full Member in years of membership. The Northeastern Section has demanded and generously received of his activity. He had a prominent part in the development of the Section's study of engineering ethics, on which the Society's Code is largely based.

Another deep interest is his beloved Massachusetts Institute of Technology. For over 65 years he has been secretary of his class. He was also secretary of the Alumni Association and has been a member of the Alumni Council since its formation.

He has an especially warm place in the hearts of Technology graduates. He loved his work, and his students venerated him. He did not eschew criticism. On the other hand, no one appreciated good work more than he; an unusual paper would receive the highest mark with the added kindly touch of "Thank you—C. F. A." His students also liked his habit of following up acquaintances or friendships, particularly if he recognized a family connection in some of their names. His engineering sense of justice often made him lean over backward in being absolutely fair.

Upon his retirement in 1916, his academic colleagues tendered him a "farewell" dinner. Twenty years later, Professor Allen returned the compliment to the members of this group. He gave an account covering the "first twenty years" of his retirement. He told of the preparation of his book on business law and of his continued activities in the various society affiliations; and he gave a genial summary of his keen enjoyment of every day during that period of "theoretical inactivity."

As one of his admirers expresses it, "He has aged gracefully." And in spite of his age, Professor Allen maintains an active mind and a keen zest for life itself. He is still a jovial companion, never missing an opportunity to produce an appropriate pun at the psychological moment. His versatility has not been at the expense of success. In fact, he has been notably successful in all his fields—first, as a railroad engineer, then as a lawyer, next as a teacher, also as an author, and now for over twenty years as a retired engineer.

Honorary Membership in the Society comes as a further recognition to this many-sided man.

ANSON MARSTON

It was toward the end of the Civil War that Anson Marston was born in northern Illinois, 100 miles west of Chicago. His boyhood was spent in that great state as it was coming into its political manhood and during the stirring days of recovery following the war. Briefly, he attended Berea College in Kentucky and then his exceptional scholastic abilities gained for him a coveted honor—

ANSON MARSTON

based on an examination in entrance mathematics—a yearly scholarship of $200 at Cornell University.

Even today this would be a fine recognition of scholastic ability. Fifty years ago it was a princely aid toward a self-sustaining college course. Anson Marston had no difficulty in retaining it for the full four years. He was a fine student, hard-working and serious-minded, with little time or perhaps no inclination for social affairs. There may have been good reason for this, for apparently he was already "booked" up with a young lady whom he afterwards married. At Cornell he made friends with many engineers who were later to attain prominence as, for example, Dean F. E. Turneaure, Hon. M. Am. Soc. C.E., with whom he lived in the same house for three years and who has remained his life-long friend.

Like many another young graduate of his day, Anson Marston immediately turned again westward. Expansion was in the air and no engineering field was more active than that of railroading. For a few years he was with the Illinois Central and the Missouri Pacific, and then in 1892 he went to Iowa State College in Ames, as professor of civil engineering. He is still there. In 1904 he was made dean of engineering, which position he held with distinction for three decades. Since 1932 he has been dean emeritus. He has seen the college develop tremendously, its engineering reputation ever widening under his guidance. To this life work he has given his very best. Always fair in his dealings with others, he has gained and held consistently the great admiration of his colleagues and students.

Those who know Dean Marston today, with his delightful sense of humor and his sly jokes, find it hard to realize that his great geniality is more or less an attainment of his later life. His army service was a most revolutionary experience. Those acquainted with him before the war never fail to remark on the great change it made in his personality. From a rather austere, cold, and unapproachable person, he was transformed in the course of two years into a lieutenant colonel and acquired the genial personality that is today so widely known and loved.

Another mellowing influence began long before the post-war period, when Dr. Marston in 1904 began his long period of association with the Iowa Highway Commission. In that service he was thrown in contact with many sorts of persons; he reached terms of intimate friendship with members of the board, and especially one from a small farming community in western Iowa. Through this association, Dr. Marston was able to bring himself to the level of thinking of the average county board of supervisors. He found that while the engineer may rationalize in terms of double integration, the average public official, especially in the smaller political units, can understand only the simplest applications of the principles of engineering.

During his years at Iowa State College, Dean Marston has been active in other ways. About 200 professional papers and technical reports have appeared under his name in various commercial and society journals. He has written research bulletins of the Iowa Engineering Experiment Station. With the present dean, T. R. Agg, he is author of *Engineering Valuation*, besides *Sewers and Drains* under his sole authorship. His consulting practice, covering design and construction of water works, sewerage systems, drainage systems, and bridges, although mainly in the Middle West, has included also important board duties in Chicago, Florida, Panama, and Nicaragua, to mention but a few. Through all the years, however, his main interest has been on his own campus. In recognition of his contribution, the college has within the past year established the Marston Medal, to be given to an engineering alumnus of maturity in recognition of achievement in the broad field of engineering. This award, in which the Society will maintain an interest through membership on the Board of Award, will long perpetuate Dean Marston's ideals.

One of his colleagues and lifetime associates was Dr. S. W. Beyer. They came to Iowa State College as young men and were boon companions until the tragic death of Dr. Beyer in a motor accident a few years ago. They hunted and fished together; each operated a farm in northern Iowa as a hobby; and each had a great liking for the out-of-doors. They were famous tennis players and in their younger days—in fact, for many years—they furnished the opposition for the college intercollegiate tennis teams. In later life, when tennis became too arduous, they took up golf together; Dean Marston still affords tough competition to the ordinary golfer.

His long friendship with Dean Turneaure began when they were classmates at Cornell. History records that once they owned a small sloop, which, either from the nautical or engineering contacts, had been named *Secant*. But upon arriving at the dock one morning, they found that the sloop had capsized during the night and was floating bottom up. So they changed its name to *Cosine*.

Except for his connection with the State Highway Commission, Dean Marston has never held public office. Nor has he given any official attention to civic affairs. His farm has been his hobby—and his professional work. As one of his oldest friends comments, "If he had chosen to remain in engineering practice, he would doubtless have become one of the staunch, honest, capable engineers who are proud of their profession and who, on the other hand, give the profession its high standing." A host of Iowa alumni, and numberless friends all over the country, will be glad that he chose the college as his field of service. His conspicuous success there and also in the Society, which he has faithfully served as Vice-President and President, are now receiving the further recognition of Honorary Membership.

ARTHUR S. TUTTLE

TO LOOK AT Arthur S. Tuttle, it is difficult to realize that he has spent 48 continuous years, except for one brief interlude, in the service of the City of New York, with some of the heaviest engineering responsibilities of a great metropolis on his shoulders. This feeling of wonder arises because there is still something boyish about him, an exhaustless energy, a ready response, a merry eye, and a jovial mood. He will never grow old.

Born at Burlington, Conn., he was graduated at the age of 20 from New York University, with the degrees of bachelor of science and civil engineer. The rapidity of his educational progress was not at the expense of its quality, as his Phi BetaKappa membership bears testimony. Immediately he entered the city employ, at first in connection with the water supply for Brooklyn. With an intermission of one year spent in Hawaii, he continued his service in 1902, being assigned to the Board of Estimate and Apportionment, arbiter of financial matters for the entire City of New York. During the following 31 years of service with the board he was successively assistant engineer, deputy chief engineer, chief engineer, and consulting engineer.

ARTHUR S. TUTTLE

To him as chief engineer came those problems which ordinarily assail a city engineer. But in this case the extent of the difficulties

and the costliness of the solution put his duties in a class by themselves. He was chief technical adviser in all matters relating to city planning, grade-crossing elimination, zoning, street improvements, sewers, sewage-treatment plants, and a variety of other engineering projects.

During his long service Mr. Tuttle has been member and chairman of many important committees. To him came such problems as the Wards Island Sewage Treatment Works, the West Side Improvement, the elimination of grade crossings on Atlantic Avenue in Brooklyn, the Manhattan approach to the George Washington Bridge, and the Jamaica Bay Improvement. One great accomplishment, a tribute to his ability, tact, and diplomacy, was the agreement with the New York Central Railroad for constructing the West Side Improvement, in which negotiations he represented the city.

He wished to give up these arduous responsibilities in 1928; in fact, he resigned at that time, but immediately was persuaded to become consulting engineer, at the same salary. So he gave of his tireless energy for four years more. Even then he was not permitted to retire on his laurels, for his services were commandeered in 1933 as a member of the New York City Emergency Work and Relief Administration. At the same time he was consulting engineer for the Citizens Budget Commission. In August of that year he became New York State Engineer for the Federal Emergency Administration of Public Works as well as resident project engineer for the government on the construction of the Triborough Bridge. A few years of this arduous work and he again resigned, to open an office as consulting engineer. Again he was not permitted to retire, for in January 1938 he was appointed consulting engineer for the WPA on construction work in New York City.

These various activities have not absorbed all his energy. In his younger days he invented a water meter to use on large mains, and an air valve for pipe lines. He has written a number of technical papers for the Society and similar organizations. During 1919 and 1920 he was chairman of Engineering Council's Committee on Classification and Compensation of Engineers. Numerous organizations have claimed his membership. In many of them, such as the Municipal Engineers of the City of New York, the Municipal Club of Brooklyn, the Metropolitan Section of the Society, and the New York University Alumni Federation, he has served as president. The United Engineering Society and the Engineering Foundation Board have also utilized his talents.

Such an arresting display of accomplishments can have but two foundations—ability and work. No one has ever questioned Arthur Tuttle's ability; his important assignments have always been laborious rather than honorary. But the fact remains that it has been work, and very hard work. His has been the "toiling upward through the night."

One of his close associates said, "All he does is work;" but this is hardly true, for he plays hard as well. He loves a party whether at home or outside; and usually he is the life of the party. The party does not need to be large, in fact one of his greatest delights is to meet at irregular times with a group of close cronies at the Engineers Club—the late George H. Pegram was a kindred spirit—in a good game of poker.

He is a convincing talker, because he knows what he is talking about. Conversely, he is a splendid judge of when is the proper time to keep still. All his life he has dealt with financial matters, of which he has a fine grasp. Of course he gets along with people—that has been his main business for years. A man in public service most of his life, and dealing with all political parties, he is not a politician. All his efforts have not been an immediate success, but this has not deterred him. He is a good sport.

It follows that he is popular with old and young. With his convivial and gregarious habits he likes to have people around him. He takes a great interest in current happenings, and in people as personalities. Perhaps this explains why he has belonged for years to the Pleiades Club, a group of people with theatrical interests, and has even been president of the club. Often he has been host at the club to parties of current and former Board of Direction members and their ladies, at the time of the Annual Meeting. He is inordinately fond of a joke and does not mind in the least if the joke happens to be on himself.

Most of his professional life he has maintained his home in Brooklyn. There his three children were born and brought up. Such extra time as he has—and one wonders when and how he can have any—he likes to spend in reading detective stories.

But in spite of all his duties and avocations, he has found much time to serve the Society. He has been a Director, its Treasurer, a Vice-President, and finally, in 1935, its President. No one can deserve the public acknowledgment of honorary membership more than Arthur S. Tuttle, and few elections to this eminence have been more popular.

EDWARD E. WALL

Service, more or less continuous, to one municipality over a period of fifty years is no mean record. It argues well for the municipality, St. Louis, and even more so for the man, Edward E. Wall. And it is the man to whom this story particularly refers. It is not even possible to put all the account in the past tense, because he is still going strong—stronger than ever, his friends say.

Edward E. Wall

He did not have to go far away or far afield to find his life work. Saline County, Missouri, where he was born, lies along the Missouri River in the central part of the state. So he early made acquaintance with the "Father of Waters." This acquaintance, some of it in later years very intimate and strenuous, has continued throughout his professional career. His first job, right out of college, was with the Mississippi River Commission at Arkansas City. Then intervened a few years on railroad work, as an introduction to his lifelong association with St. Louis.

His first job with the city began in 1888 and lasted less than a year, but he reestablished a connection in 1892 and this time it was "for keeps." One opportunity after another led him on in the city water and sewer department. Ability and energy won its reward—by 1906 Mr. Wall had reached the position of assistant water commissioner and in 1911 he was made water commissioner of the city. The heavy duties of this work continued until 1925, when he was promoted to the office of director of public utilities.

In this period, Mr. Wall, although he was not what is generally known as a politician, and in fact had served various political parties with equal success, nevertheless had acquired a thorough working knowledge of practical politics. He has always been known as a man of unusually high ideals and, while reasonably practical in his efforts to follow them, he was not always as sympathetic as he might have been with petty people. This attitude kept him quite commonly in hot water with the politicians, not only with those in his own party but with those of the opposition, under whom he held administrative office through two administrations.

It was a mayor of his own party, and his superior, with whom he had his most notable conflict, when he was director of public utilities. He had held this office for less than a year when the mayor demanded that he discharge a subordinate who had incurred the mayor's ill will. Mr. Wall refused, because the man was competent. A hot fight ensued, culminating in a public trial. The charges were, shall we say, contumacy, although that word was not so very well known then. Of course there was only one outcome, and Mr. Wall was discharged.

But he came back, and to this same position, in 1933, and it has always seemed to his engineering friends that his continuous and successful maintenance of this office ever since has exonerated him fully from any suspicion of blame connected with the earlier episode and has reestablished him as an engineer and public servant par excellence.

From a casual contact with Mr. Wall, or from business dealings with him, one gets the impression at first that he is a quiet man,

almost taciturn. But upon further cultivation he turns out to be unusually genial and a warm friend. His personal intimates are found in a small circle of congenial friends, most of them members of the engineering profession, such as Baxter L. Brown, M. Am. Soc. C.E., and the late Philip N. Moore, formerly president of the Institute of Mining and Metallurgical Engineers.

Some years ago Mr. Wall published privately a collection of his miscellaneous writings, principally after-dinner talks, under the title, *Engineers, Engineering, and Some Vagaries.* This volume not only shows his wide knowledge of literature, on a great variety of subjects, but indicates that he uses readily, and is proud of being able to use, thoroughly good English. In this respect he is a continuing fine example to younger engineers. The volume is also a tribute, as the dedication expresses it, "to one who has dealt gently with my shortcomings, been patient with my moods, encouraged me in my dark hours, rejoiced with me in happy moments, to my life-long partner—my wife."

Of the forty subjects treated in this interesting book, many have to do with St. Louis engineering works; other titles indicate the deep-seated professional interest of the man when he wrote on "Engineering Ethics," "The Engineer in Politics and Business," "General Education for the Engineer," "Helping Each Other to Help the Profession," "The Human Side of Engineering," "The Lure of Engineering," "Registration of Engineers," and "The Status of the Engineer." But there are other facets of his life-long interest, as attested by such various titles as "Luck," "One Honest Man," "Our Baby," "Advantages of Not Being Too Clever," and "Solitaire." Thumbing through the leaves, one notes many references to the Society, some complimentary and some questioning. He acknowledges that through the years his views, as witnessed by the dates on the articles, may have changed, but this needs no apology, as "inconsistency is the bane of feeble minds." As an example, a change in Mr. Wall's views on registration from early doubt to later satisfaction, and advocacy of the Society's Model Law, may be noted. A generous sprinkling of poems on various topics is also included.

Doubtless the greatest attainment of Mr. Wall's career has been, and still continues to be, increasing the quantity and quality of drinking water for St. Louis. One of his most exhilarating experiences was his part in first furnishing to the citizens a clear water, free from the silt that had always been present. Particular point was given this exploit by the impending opening of the Louisiana Purchase Exposition, which was to entertain visitors from all over the world. But the battle was not always easy; Mr. Wall tells of the intense struggle in January 1912, during a severe cold spell, to keep open the wet well of the intake, with men and machines working continuous eight-hour shifts for nine days and nights—"except the engineers, who were on duty all the time." In this battle, as in all others, Edward E. Wall was the victor.

In 1908 his authorship of the notable paper on "Water Purification at St. Louis, Mo.," won for him the Society's Thomas Fitch Rowland Prize. In further recognition, in 1935, the University of Missouri conferred on him the honorary degree of doctor of laws. In St. Louis he has served both the Engineers' Club and the Institute of Consulting Engineers as president. His fellow members in the Society gave him their warm endorsement when he was elected Director for 1918–1920 and Vice-President, 1921–1922.

A few months ago his seventy-eighth birthday was made the occasion of quite a civic demonstration. The date was also a reminder of his fifty years of service, forty with the city of St. Louis. Reporters interviewed him and took his photograph; two main editorials bore tribute to his civic accomplishments. Even more than the man on the street, the engineers of St. Louis are very proud of Edward E. Wall. An even wider recognition is now awarded him as he accepts the Society's high tribute of Honorary Membership.

FRANK E. WEYMOUTH

MAINE has turned out some fine engineers, but few have added greater luster to her reputation than Frank Elwin Weymouth. He was born in the central part of the state, Medford, in 1874, and finished his schooling at Fort Fairfield. Those whose geography needs a little polishing will bear reminding that this is on the very eastern border of the state and is not far from being on the northern border as well. Putting it another way, it is in the very northeastern corner of the most northeastern state; and if there is any point in the country that is farther away from the southwestern corner of California, where Mr. Weymouth was to achieve his greatest engineering success, the maps fail to disclose it. Between these extremes of distance, the whole great country lies, and between these extremes in Weymouth's life lies a vast expanse of experience and responsibility.

After graduating from the State University in 1896, his first work was with the Massachusetts Metropolitan Water District (Boston). Curiously enough, this was on water works construction, presage of things to come. Next he was for a time with the city of Winnipeg, and just at the turn of the century he was for a few months engaged in making surveys and studies in connection with the proposed Nicaraguan Canal. In these early jobs Mr. Weymouth established an enviable reputation for ability and industry and formed many firm friendships with engineers destined to be numbered among the leaders of his generation.

FRANK E. WEYMOUTH

One of his greatest and longest associations began in 1902 when he joined the engineering organization of the U. S. Reclamation Service (now the Bureau of Reclamation), just created. In various capacities and in increasing responsibilities, he served this bureau continuously for 22 years.

During this period Mr. Weymouth set new standards of efficiency in public works and developed an ability which he has never lost—that most desirable asset of gaining and holding the confidence of his associates, from the highest official to the last subordinate. Although the diametrical opposite of a "politician" in the popular sense of the word, he readily found the sympathy and support of important people in Washington and throughout the wide area over which his activities were spread. These characteristics were destined to play an important part in his subsequent achievements.

From 1916 to 1920, Mr. Weymouth served as chief of construction in charge of all construction work undertaken by the Reclamation Service, and in 1920 he was made chief engineer of the Bureau, a post which he held until his resignation in October 1924. During this period, under Mr. Weymouth's leadership, the Reclamation Service was signally successful in planning and building irrigation works throughout the western United States. One of his outstanding achievements as chief engineer was his work on early surveys, plans, and estimates for the Boulder Dam project. In fact, the "Weymouth Report" furnished the basis of facts and figures upon which the final decision as to the feasibility of this project rested.

Upon leaving the Reclamation Bureau, he became president of the engineering firm of Brock and Weymouth of Philadelphia, Pa. In 1926 he was made chief engineer of the J. G. White Engineering Corporation in Mexico, in charge of its extensive work for that republic.

About this time the City of Los Angeles was canvassing the engineering field for an eminent engineer to take charge of its tremendous water supply problem. Mr. Weymouth's friends were not surprised when, in 1929, he was retained by the city as chief engineer of water works and placed in charge of the Colorado River Aqueduct studies then being carried forward by the city. Later that year he was appointed chief engineer of the Metropolitan Water District of Southern California, which had been formed to take over this project, and in 1931 he was promoted by appointment to the position he now holds, that of general manager and chief engineer of the District. Then he became the District's main administrative officer as well as its chief engineer.

Upon his arrival in Los Angeles to take over his new work, Mr. Weymouth found that physical development had gone far beyond the safe annual yield of existing water resources. The community was facing the difficult alternatives of bringing in a new water supply from an outside source or of serious retrogression. The only source of a new water supply was the Colorado River, which lay 300 miles away and at the time lacked the storage facilities required to conserve its variable flow for domestic diversion. The problem of tapping this river for the benefit of the cities of Southern California was committed to Mr. Weymouth. The tremendous difficulties involved and the high degree of success achieved in the engineering solutions are too well known to need repetition here.

Such a brief recital of professional accomplishment gives only an inadequate picture of Mr. Weymouth as a man. He has lived very intensely in his private as well as in his professional life. Every action is taken purposefully—he drifts into nothing. If a task, large or small, is to be done, he knows how he wants it done and he follows it personally until its accomplishment is assured.

This characteristic is forcefully illustrated by a story told by Mr. Weymouth's close friend and associate, the late A. J. Wiley, M. Am. Soc. C.E. During an early inspection trip to Boulder Dam site, a party of engineers stopped for breakfast at the railway restaurant at Las Vegas, Nev. Mr. Weymouth asked for bacon, and as usual, ordered it "C R I S P," all capital letters and underscored. The order was taken by an attractive young waitress who carefully noted the specifications for crispness.

As the waitress disappeared with the order, her charming manner was volubly commended. Soon the bacon arrived—fairly crisp to you or me, but raw to Mr. Weymouth. He sent it back to the fire. Returning soon, with an added degree of dessication, it was again declined, regretfully, and started on another trip to the kitchen. It appeared once more, this time really done—that is, in the opinion of Mr. Wiley—but not so to Mr. Weymouth. He informed the sweet young waitress, still regretfully but firmly, that he really wanted the bacon cooked and asked that she please explain this to the chef. Without the least appearance of perturbation, she headed again for the rear. As she disappeared into the smoke of the kitchen her dulcet voice came back through the swinging doors as she greeted the cook with: "Burn it up for the ———!!!" She soon returned with her smile and a few charred strips that were just what the doctor (and Mr. Weymouth) had ordered.

The moral has nothing to do with the sweet young waitress, but relates to persistence as a means of getting what one wants. With Mr. Weymouth it may be bacon, the draft of a letter, a report, plans for a concrete plant or a dam. It goes back until it is right, and he has never a thought of becoming discouraged and giving in at a half-way point.

These and similar remarkable traits have led to his outstanding success. His accomplishments have been recognized by his alma mater, which has bestowed on him an honorary doctor of engineering; they are now similarly recognized by his professional associates in this Honorary Membership in the American Society of Civil Engineers.

Forecast for January "Proceedings"

An almost unprecedented surge of new discussion made it necessary to defer publication, for one month, of a few of the seven papers "forecast" for the December "Proceedings."

Beach Erosion Studies

By Earl I. Brown

A comprehensive discussion of the factors to be kept in mind by those who must try to make shore lines behave.

Graphical Analysis Applicable to Arch Dams

By Carl H. Heilbron, Jr., Assoc. M. Am. Soc. C.E. and William H. Saylor, Jun. Am. Soc. C.E.

A detailed step-by-step explanation of a method of analyzing arches, the stresses and deflections being determined with all necessary accuracy, by graphics.

Engineering Geology Problems at Conchas Dam

By Irving B. Crosby, Affiliate Am. Soc. C.E.

A discussion of the strength of the underlying rock formations, in terms useful to the civil engineer.

The Risk of the Unexpected in Subsurface Construction Contracts

By Oren Clive Herwitz

Legal hazards inherent in engineering contracts and suggestions for avoiding them by proper phrasing.

Flood Protection Data: Progress Report of the Committee of the Society on Flood Protection Data

A concise and well-organizep statement of advances made in this field, including a list of most recent publications.

Robert Ridgway, 1862-1938

Even the closest of his legion of friends were dumbfounded to hear of the death on December 19 of Robert Ridgway, Past-President and Honorary Member. He was active until the very last. In fact it was while returning to New York after participating in the function of breaking ground for the beginning of subway work in Chicago—a project on which he had been doing important consulting work for months previously—that he was stricken on the train. He was taken to the hospital in Fort Wayne, Ind., where he died.

Largely self-tutored, Robert Ridgway was a well-educated man and a most capable engineer. His lifetime of work was spent principally in service for the City of New York, on its Board of Water Supply until 1912, and from then onward in connection with the design and construction of city subways. His direct supervision in this latter department, including over ten years as chief engineer, totaled many hundreds of millions of dollars worth of contracts.

His consulting work, in addition to that on the Chicago subways, included similar studies for Osaka, Japan. He was also on the consulting board for Boulder Dam and on that for the Trans-Bay Bridge between San Francisco and Oakland.

In the Society he had served in many offices of importance up to the presidency and on many committees and representative bodies. He has been vitally interested in the work of the Alfred Noble Prize Committee from its very beginning years ago.

No worthy project for professional well-being failed to receive his heartiest support. He was a loyal attendant at Society meetings of all kinds and was especially in demand for student gatherings. His record and personality were an inspiration to all young men, and he always emphasized the value of the technical training that he himself, to his lasting regret, had missed.

His professional work and Society affiliation gave Mr. Ridgway an unusual opportunity to develop his genius for service and friendship. As a result, he was perhaps one of the most loved and lovable engineers in America. He has been singled out not only for Honorary Membership in the Society, but for honorary degrees by four universities. Thousands of engineers held him in deep admiration and warm affection.

Robert Ridgway

Pros and Cons of Federal Public Works Department

Review of Recent Society Activities and Discussions, Compiled by the Committee on Publications

THE HISTORY of federal public works agencies has been marked by various attempts to change the organization of these agencies, to consolidate some of them or to bring them all together into a single Federal Department of Public Works. This latter proposal was again brought forward, in connection with the President's proposed reorganization plan, in the fall of 1937. At its meeting in Boston that year the Board of Direction was urged to support this proposal, and a vote showed a majority favoring the creation of a Federal Department of Public Works.

Following this action it was decided to make this subject the topic for discussion at the "general meeting" of the Society held in New York in January 1938. At this time various speakers described at length the advantages of such centralization of federal public works activities, while others, with equal force, noted both the difficulties involved in effecting such a merger and the possible dangers of a super-department of this type.

The Board realized that there were clearly strong arguments both pro and con. It was also convinced, however, that the basic problem involved was the more efficient and effective organization of an engineering activity of government and that engineers should not only be qualified to offer advice on this subject but that, in line with public service, an attempt should be made to reach a decision which could be brought forward as embodying the advice of the profession as the result of an intelligent, unbiased, and impartial study.

Accordingly, a Special Committee, under the chairmanship of Daniel C. Walser, M. Am. Soc. C.E., was appointed by the Board. The report of this Committee reached the Board at its meeting in Salt Lake City last July. The Board received this report with appreciation of the excellent work, and ordered it printed in CIVIL ENGINEERING (see issue of September 1938, page 624), with an invitation to the membership to submit "informed discussion" of its recommendations. The Committee on Publications was asked to summarize these discussions for similar publication.

COMMITTEE REPORT ON PUBLIC WORKS

In its report the Special Committee stated, as a result of its studies of previous attempts at consolidation and of the advantages to be gained therefrom, that in its opinion it would be practically impossible to secure such a merger of federal public works activities and that it was doubtful whether the creation of a Department of Public Works, even if possible, was desirable. It recommended, as a progressive and constructive step, and one which would do much to correct the major items which engineers have in mind, the creation of a Federal Board of Public Works, similar supposedly to the Federal Board of Surveys and Maps but having, presumably, somewhat greater powers.

The Committee noted, of course, that there was some duplication of effort among the comparatively few federal departments which undertake public works but apparently felt that this was relatively small in amount and that, should a public works department be organized, a division of activities very similar to that now existing would inevitably be made in its organization. Furthermore, it was clear that the present federal agencies were already firmly established with more or less divergent interests and with many ardent supporters, and, from a purely practical standpoint, had successfully resisted, and undoubtedly would continue to resist, all attempts to consolidate their interests or to take away their construction duties.

Apparently the Committee felt that criticism of federal public works activities was directed more at the matter of policy and coordination of efforts than at any lack of technical ability, great duplication of effort, or low efficiency in the departments involved. The engineer, in particular, objected to the fact that these federal departments too often regarded themselves solely as the agents of Congress, as not responsible for the economic or social values connected with their labors, or the possible direct or indirect returns from proposed projects. The decision to build or not to build rests too often on political expediency or with pressure groups rather than on fact finding, careful study, and a balancing of economic and social pros and cons.

It would appear, therefore, that a Federal Board of Public Works, consisting of representatives of the various federal bureaus engaged in the design, construction, or operation of public works, plus representatives of the engineering and architectural professions and the construction industry, offered the most practical solution of the problem. Such a board would provide an effective agency for reviewing projects of this nature, recommending procedures, coordinating such individual activities as involved common problems, and eliminating, through cooperation, unnecessary duplication of efforts or of staff. Furthermore, while any single agency might resist a merger plan, these agencies could not very well refuse to thus join with other agencies in the interest of uniformed practice in the solution of common problems.

DISCUSSION

Considering the various discussions of this report in order of receipt we turn first to that of Thorndike Saville, M. Am. Soc. C.E., who has been active in connection with the Water Resources Committee of the National Resources Committee. Dean Saville states that the proposal to form "a reviewing and coordinating agency of the federal government to function with respect to all existing operating agencies to bring about cooperation, to eliminate worthless projects, to place meritorious projects in their proper priority, and to act as a clearing house capable of making valuable recommendations to the Federal Bureau of the Budget" is completely in line with various suggestions he has made and almost completely describes the major activities of the above-mentioned Water Resources Committee.

Alonzo J. Hammond, Past-President of the Society and a member of American Engineering Council, was one of the speakers at the general meeting in New York last January, at which time he reviewed in detail the history of the various efforts toward establishing a Federal Department of Public Works. In his discussion of the Committee report, Mr. Hammond again reviews the findings of, and the opinions expressed by, engineers and experts in public administration in the past and states that they have in general been uniformly favorable—they have advocated the organization of such a department. He states: "I believe wholeheartedly in a Federal Department of Public Works, and that it is only a question of time for such a department to materialize." He emphasizes the economies that might be effected, states that, in view of the magnitude of present-day business, such a department would not be unwieldy, and argues that, "as to the setting up of a reviewing and coordinating agency, if we had a Department of Public Works that would be done automatically."

With his comments Mr. Hammond submitted a brief paper by George F. McDougall of Portland, Ore., a member of the Committee on Public Works of the American Engineering Council. This paper states that "economics and politics are two different horses, pulling in opposite directions on the same cable" and goes on to suggest that "Democratic government, with its head and popular representatives chosen for their popularity rather than ability, must of necessity have trained personnel in its various departments." The men who become titular heads of departments have neither the knowledge nor the training to appraise or give the "once over" to the work of their subordinates—the engineers in their department. Public works is at present, Mr. McDougall states, the greatest (federal) activity by far, and is foundering in the sea of undiluted politics. "If public works are to continue there must be a better way of handling them."

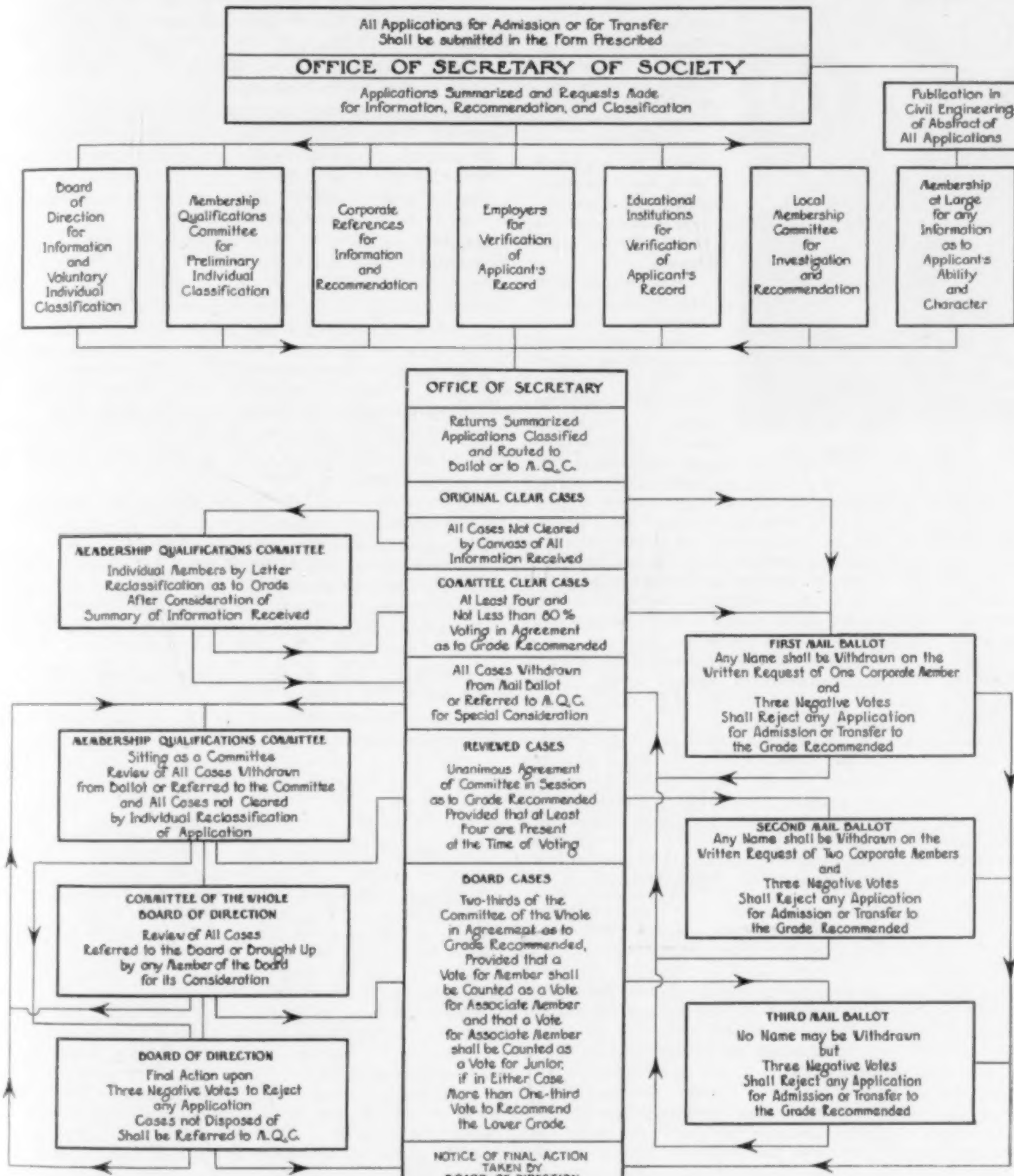
Under date of September 20, Herbert S. Crocker, a Past-President of the Society, wrote that, during his service on American Engineering Council, federal public works were frequently discussed; and it seemed to be the almost unanimous opinion that a Federal Department of Public Works of some kind was most desirable. "While many constructive efforts have been made to outline an organization which would result in economies in administration, as well as facilitate the handling of public works in which engineering is involved, so far without complete success there is no reason to despair even though there will always exist opposition from politicians and government employees whose jobs might be imperiled by any change whatever." He is therefore opposed to the recommendation of the Committee that this idea of a federal department be abandoned in favor of the Committee's own and "unique" idea of a reviewing and coordinating board

He feels, however, that the immediate present is not a propitious time for further action—"wait until the present political hubbub has subsided."

Also in discussion, Walter M. Paddock, Assoc. M. Am. Soc. C.E., agrees that the formation of a Federal Department of Public Works would be difficult—but not impossible. "It is my belief," he states, "that all federal engineering and construction activities should be under the jurisdiction of a department such as has been proposed and that all funds for federal building and heavy construction projects should be under the control of such department in order that the moneys might be expended for projects for which there was the greatest need and which would give the nation as a whole the greatest benefit. I also believe that within such a department there should be a Planning Commission composed of capable federal employees and private citizens who would formulate a long-range federal program and coordinate the various federal construction activities."

The Committee on Publications realizes that the subject of public works is a large one and is far from being exhausted. It therefore anticipates that there will be further studies as new views and possibilities are opened from time to time.

COMMITTEE ON PUBLICATIONS
By James K. Finch, Chairman



PROCEDURE FOR SOCIETY MEMBERSHIP APPLICATIONS

A Graphical Explanation of the Handling of Applications for Admission or Transfer, from Their Submission to the Secretary's Office to the Final Action of the Board of Direction. The Article by Raymond A. Hill, on Page 11 of this Issue, Discusses in Detail Many of the Steps Indicated Here

Edwin P. Arneson Dies

MEMBERS of the Society will be shocked to learn of the death of Edwin P. Arneson, Director of the Society, which occurred in San Antonio, Tex., on December 7, 1938. Mr. Arneson was born in Fort Worth, Tex., on July 25, 1888. In 1910 he was graduated from the Agricultural and Mechanical College of Texas with the degree of B.S. in C.E., and in 1929 he received the degree of C.E. from the same institution.

During the year following his graduation he was employed by the Texas Company, of Houston, Tex., on the design of warehouses, wharves, and similar structures, and from 1911 to 1913 he was office engineer for the Medina Irrigation Company of San Antonio, Tex., on surveys and the construction of a canal system. The next year he was employed on various projects for the Ebro Irrigation and Power Company, of Barcelona, Spain.

EDWIN P. ARNESON, 1888–1938

In 1914 and 1915 Mr. Arneson was in immediate charge of surveys and studies for a drainage project at Waco, Tex., and from 1915 to 1916 he was chief draftsman in the office of the city engineer of San Antonio, Tex., supervising the design of extensive municipal improvements. From December 1916 to March 1930, with the exception of a brief period spent in War service, he was a member of the San Antonio civil engineering firm of Walton and Arneson, engaged in topographic surveying and irrigation, highway, and structural projects. During the War he served in the Navy Department in the capacity of structural draftsman on the design of shipbuilding ways, crane runways, and waterfront improvements.

From March 1930 until his death Mr. Arneson was in private civil engineering practice, specializing in highway work. For a time during this period he was also director of Works Progress Administration, Texas District No. 10.

Mr. Arneson became an Associate Member of the Society in 1919, and a Member in 1932. Long active in the Texas Section, he served as president in 1932. In 1936 he was elected a Director of the Society, and his term would have expired in January 1939.

His fine mind, industrious cooperation, and good sportsmanship, and his hearty devotion to all that is best in the profession, endeared him to his associates on the Board. They and his host of Texas friends will greatly miss jovial "Eddie" Arneson.

108 Years of Service

IT IS a long time—108 years—even when it is divided among three people. It represents the contributions of three individuals who are now retiring from the Society staff.

Of these, Miss Matilda Steinbrenner has given 40 years, lacking a few days; Miss Ida Fredericks, an almost equal amount; and Miss Mary Moorman about 28 years. Together they have had a definite share in much of the output of the Society during its period of greatest growth. Miss Steinbrenner has supervised the styling and printing of PROCEEDINGS and TRANSACTIONS—with the painstaking attention to detail that has given these publications an unusual accuracy, and a continuous persistence that has brought them out always on time. Miss Fredericks has been head of the stenographic department, with the supervision of many of the numerous duties that are involved in a busy office. Miss Moorman has had charge of the current membership records, the changes of address, and other statistics in the constantly changing membership of over 15,000 engineers.

Fortunate indeed is any organization that can boast of staff members so capable and so long in the service. The Society is the richer for the conscientious efforts of these splendid women. As they retire on December 31, they carry with them the best wishes of the Board and the entire staff of their co-workers.

News of Local Sections

Scheduled Meetings

CLEVELAND SECTION—Dinner meeting at the Guildhall on January 9, at 6:15 p.m.

DAYTON SECTION—Luncheon meeting at the Dayton Engineers Club on January 16, at 12:15 p.m.

DISTRICT OF COLUMBIA SECTION—Annual banquet on January 22, at 7:30 p.m.; meeting of Junior Forum on January 16.

GEORGIA SECTION—Luncheon meeting at the Atlanta Athletic Club on January 9, at 12:30 p.m.

KANSAS STATE SECTION—Dinner meeting at the Kansan Hotel in Topeka on January 12, at 6:30 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on January 11, at 6:15 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building in New York on January 11, at 8:00 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on January 5, at 7:00 p.m. (Winter-vacation visitors to Miami are urged to meet with the Section on the first Thursday of each month.)

ROCHESTER SECTION—Annual dinner meeting at the Central Y. M. C. A. on January 5, at 6:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the Mayfair Hotel on January 23, at 12:15 p.m.

SEATTLE SECTION—Dinner and annual business meeting at the Engineers Club on January 30, at 6 p.m.; Ladies Night early in the month (date not set yet).

SOUTH CAROLINA SECTION—Annual meeting at the Hotel Columbia, Columbia, S.C., on January 6, at 10:00 a.m. (joint meeting with the South Carolina Society of Engineers).

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A. on January 17, at 6:30 p.m.

WYOMING SECTION—Annual Meeting at the Plains Hotel in Cheyenne on January 12, at 7:00 p.m.

Recent Activities

ARIZONA SECTION

The annual fall meeting of the Arizona Section took the form of a two-day session, held in Phoenix on November 26 and 27. Following registration at the Westward Ho Hotel, Clyde Myers, president of the Section, gave an address of welcome. During the annual business meeting, which was next on the program, new officers were elected as follows: John C. Park, president; Vic H. Housholder, first vice-president; Julian W. Powers, second vice-president; and W. T. Wishart, secretary-treasurer. The following speakers were then heard on the technical program: G. E. P. Smith, professor of irrigation engineering at the University of Arizona; J. A. Fraps, resident engineer for the U. S. Bureau of Reclamation on the construction of Bartlett Dam; C. V. Theis, associate geologist, U. S. Geological Survey; and Howard S. Reed, state highway engineer. At noon a joint luncheon with the Phoenix chapter of the American Association of Engineers was enjoyed. Walter J. Thalheimer, mayor of Phoenix, welcomed this gathering, while the principal address was given by the Rev. Edwin S. Lane. The afternoon program included a memorial to the late Louis C. Hill, given by Mr. Reed, and several technical lectures. These were presented by Swan A. Erickson, state certification engineer; Don C. Scott, secretary of the Colorado River Commission; A. F. Rath, resident engineer for the Arizona State Highway Department; and D. A.

Holm, oil geologist with the Arizona State Land Department. A banquet that evening concluded the day's activities. The program on the 27th included a joint inspection trip with the American Association of Engineers to Bartlett Dam, where the group lunched. The attendance at the technical sessions varied from 60 to 72, and there were 110 at the joint luncheon.

Buffalo Section

There were 25 present at a luncheon meeting of the Buffalo Section, which was held at the Buffalo Athletic Club on November 15. Following a brief business session, President Minniss discussed the Rochester Meeting of the Society and said that 15 members of the Buffalo Section had been able to attend. He then introduced the speaker of the day, Edward H. Letchworth, attorney and chairman of the Building Foundation Committee of the Buffalo Foundation. Mr. Letchworth gave a summary of the social studies and work accomplished by the Foundation in the past.

Central Illinois Section

The Central Illinois Section met with the Champaign County Chapter of the Illinois Society of Engineers at a dinner meeting in the Inman Hotel in Champaign on October 27. The 44 members present on this occasion enjoyed hearing Albert H. Lybyer, professor of history at the University of Illinois, discuss the factors involved in the present European political situation. A favorable report from the Section delegates to an organization meeting of the Illinois Engineering Council caused the Section to apply for membership in the Council.

Central Ohio Section

A luncheon meeting of the Central Ohio Section took place at the Chittenden Hotel in Columbus on November 17, with 26 present. After a business meeting P. M. Holmes reported on the Local Sections Conference held at the Rochester Meeting, to which he had been the Section's delegate. The technical program consisted of an illustrated talk by Dr. Anson Hayes, director of research for the American Rolling Mills Company, of Middletown, Ohio. Dr. Hayes' subject was "Some New Uses of Sheet Metal."

Dayton Section

On November 21 the Dayton Section held its regular November luncheon meeting at the Dayton Engineers Club. Following the usual business session, a technical program was presented. This consisted of a talk on the history and geology of the Grand Canyon, which was given by W. A. Chryst, consulting engineer for the General Motors Corporation. Mr. Chryst spoke from information gained on a recent trip through the Grand Canyon, which was made with members of the Explorers Club. The attendance of 26 included members of the University of Dayton Student Chapter.

District of Columbia Section

The annual business meeting of the District of Columbia Section took place in Washington, D.C., on November 22. The annual reports of the secretary and treasurer were read, and various committee reports were given. R. W. Crum then discussed the establishment of the highly successful Junior Forum of the Section and called on T. Ritchie Edmonston, secretary of the group, for a report of its activities. The annual election of officers, also held at this time, resulted as follows: W. E. Reynolds, president; John C. Page, vice-president; Clifford A. Betts, secretary; and Benjamin E. Jones, treasurer. The showing of motion pictures—entitled "Conquest of the Hudson" and "The Wonder World of Chemistry"—concluded the evening.

Illinois Section

On December 3 the Illinois Section gave a dinner for the new Committee for the Professional, Economic, and Social Development of the Engineer. There were 68 members present on this occasion to hear reports of the committee's tentative plans and objectives.

At the November meeting of the Junior Section of the Illinois Section, J. R. Van Pelt, assistant director of the Museum of Science and Industry in Chicago, reviewed the history of the museum and reported on its progress. He also explained the theory behind the present arrangement of the exhibitions and described in detail some of the problems encountered.

Indiana Section

Following its annual custom, the Indiana Section sponsored a fall inspection trip for senior-class engineering students at Purdue University. This trip, which was held November 2 to 5, took in many places of interest in and about Chicago. Perhaps the high light of the occasion was the dinner meeting, given for the group by the Portland Cement Association. The principal speaker at this gathering, which took place in Chicago on November 4, was Charles De Leuw, consulting engineer of Chicago, who has been retained as designing engineer for the Chicago subway. Mr. De Leuw gave a concise analysis of the traffic problems of Chicago, showing the need for the subway to relieve the congestion in the Loop district. The attendance at this dinner included 60 students from Purdue, 10 members of the Indiana Section, and a number from the Illinois Section. On November 16 the Section held a dinner meeting in Indianapolis, with 27 present. The speaker at this session was Robert Kingery, general manager of the Chicago Regional Planning Association, who outlined the formation and growth of the association. During the past sixteen years the association has acted as a clearing house for the traffic problems of Chicago and its environs, and slides showing population and traffic trends added to the interest of the occasion. E. R. Feldman, director of the traffic survey for the Indiana State Highway Commission, discussed the results of traffic research in the Calumet (Ind.) region.

Iowa Section

The twentieth annual meeting of the Iowa Section was held in Des Moines on November 17. The attendance at the afternoon session was 40, and at the dinner and evening session 35. During the annual business session the following officers were elected: A. H. Wieters, president; E. W. Lane, vice-president; and R. B. Kittredge, secretary-treasurer.

Ithaca Section

There were 65 members and guests present at the November meeting of the Ithaca Section, which took the form of a joint session with the Cornell University Student Chapter. The speaker on this occasion was Howard T. Critchlow, chief engineer of the New Jersey State Water Power Commission, who presented a paper on "The Present and Future Use of the Delaware River Watershed for Metropolitan Water Supplies." Preceding the talk, there was a dinner in Willard Straight Hall on the campus of Cornell University, which was attended by 30. At the annual meeting of the Section (reported in the December issue of CIVIL ENGINEERING) P. H. Underwood was elected president of the Section, and Carl Crandall, vice-president.

Kansas City (Mo.) Section

A regular session of the Kansas City Section was held at the University Club on November 16. There were 53 present for the dinner and the technical program following it. Henry E. Riggs, President of the Society and guest of honor, made the principal address of the evening, his subject being Society affairs. In his talk Dr. Riggs outlined the efforts of the Society to advance the profession. The other guests of honor were Ivan C. Crawford, former Director of the Society, and Prof. E. L. Eriksen, of the mechanical engineering department at the University of Michigan. An hour of excellent music and entertainment followed the technical program.

Kansas State Section

The Kansas State Section of the Society and the Kansas State College Student Chapter enjoyed the hospitality of the University of Kansas Student Chapter at Lawrence on November 18. A fine dinner, served to 122, initiated the program. T. C. Maichel, president of the University of Kansas Student Chapter, acted as toastmaster, while Walter Hanson, president of the Kansas State College Chapter, spoke in behalf of his delegation. Another pleasant feature of the occasion was group singing, which was led by Prof. J. O. Jones. President Riggs was speaker and guest of honor.

Los Angeles Section

On November 9 the Los Angeles Section held its annual Ladies' Night at the University of Southern California. Members of the Student Chapter at the university were hosts to the Section and furnished musical entertainment. Following dinner, which was served to 196, President Rawn presented Charles T. Leeds, nominee for Society Director. Colonel Leeds spoke briefly about the late Louis C. Hill. The principal speaker of the evening was Dr. John E. Harley, professor of political science at the University of Southern California, who discussed the European situation. Dr. Harley

also showed colored motion pictures taken by him in Palestine and Czechoslovakia. At the conclusion of this program, dancing was enjoyed.

Metropolitan Section

A symposium on the subject of welding was enjoyed at the November meeting of the Metropolitan Section, which took the form of a joint session with the New York section of the American Welding Society. The speakers on this program, which was held in the Engineering Societies Building in New York on November 16, were F. H. Frankland, chief engineer of the American Institute of Steel Construction, and C. E. Loos, assistant mechanical engineer for the American Bridge Company. The discussion, which covered welding in the structural field and structural fabrication by welding, was followed by a technicolor motion picture of welding in New York City. A social hour followed the meeting, which was attended by 525.

The Junior Branch of the Section held its meeting on November 22. On this occasion a motion picture on the subject, "Bridging a Century," was enjoyed through the courtesy of John A. Roebling's Sons Company. Of particular interest on this program was the showing of the erection and spinning of cables for the Golden Gate Bridge.

Michigan Section

On November 22 the Michigan Section held a joint dinner meeting with the newly organized University of Detroit Student Chapter. The occasion was particularly auspicious for an inauguration, as both President Riggs and J. B. Challies, presidentof the Engineering Institute of Canada, were present. President Riggs gave a talk, as did Prof. Clair C. Johnston and Dean Freund, both of the University of Detroit. In another brief talk Harry Tumidajewiez, president of the University of Detroit Student Chapter, introduced the student officers. The main speaker of the evening was Ralph B. Wiley, head of the civil engineering department at Purdue University, who outlined the work of the Society for the Promotion of Engineering Education in accrediting engineering colleges. There were 80 at the meeting and about 50 at the dinner preceding it. E. D. Rich, president of the Section, acted as toastmaster.

Mid-Missouri Section

A special luncheon meeting of the Mid-Missouri Section was held in Jefferson City on November 15 to honor President Riggs and Professor Eriksen. Dr. Riggs gave a brief talk that proved of interest to the 19 members present.

Mohawk-Hudson Section

The first annual meeting of the Mohawk-Hudson Section took place at the Hendrick Hudson Hotel in Troy, N.Y., on November 28, with 77 present. This session was preceded by a dinner in honor of the guest speaker, John P. Hogan, chief engineer and director of construction for the New York World's Fair. Colonel Hogan gave an illustrated address on the subject, "Engineering Features of the Fair." During the business session the following new officers were elected: Edward W. Wendell, president; Charles A. Harrell, vice-president; Paul R. Speer, secretary; and G. Reed Shaw, treasurer. A vote of thanks was given the retiring president, Warren C. Taylor, who has done much for the new Section. Although less than a year old, the Section has already enrolled in its ranks about 28 per cent of the Society membership in the territory and has ambitious plans for the future.

Northwestern Section

A combination dinner meeting and inspection trip was enjoyed by 52 members and guests of the Northwestern Section on October 3, when the group visited the Pig's Eye Island (St. Paul) Sewage Disposal Plant. Following dinner George J. Schroepfer, chief engineer of the Minneapolis-St. Paul Sanitary District, gave an interesting résumé of plant operation to date. Those present then inspected the plant. On November 7 a dinner meeting was held in the new hydraulics laboratory of the University of Minnesota, with 61 present. Following dinner and a business session, the group heard George E. Loughland give a talk on the history of St. Anthony Falls in general and of the site occupied by the laboratory. Mr. Loughland is hydraulic engineer for the Northern States Power Company. Lorenz G. Straub, professor of hydraulics at the University of Minnesota and president of the Section, also discussed the laboratory.

Providence Section

Prof. Charles F. Brooks, of the Blue Hills Observatory at Harvard University, was the speaker at a meeting of the Providence Section, which took place on November 9. Professor Brooks discussed the meteorology of the New England hurricane of September 1938, using lantern slides to illustrate his talk. There was an audience of 80.

St. Louis Section

Following its yearly custom, the St. Louis Section entertained the senior-class engineering students at Washington University, the University of Missouri, and the Missouri School of Mines and Metallurgy at its annual dinner meeting on November 19. Dr. William E. Wickenden, president of the Case School of Applied Science, drew upon his rich teaching experience to give the principal address of the evening, which was on "The Young Engineer Facing Tomorrow." President Riggs, a special guest of honor, spoke briefly on the aims of the Society and of the engineering profession. During the business meeting the following officers were elected for the new year: John T. Garrett, president; Paul S. Reinecke, vice-president; R. D. Schmickle, secretary-treasurer; E. C. Constance, councillor; and John I. Parcel, alternate councillor.

San Diego Section

On November 11, in lieu of the usual dinner meeting, members of the San Diego Section took a trip to Los Angeles, where a visit was made to the Columbia Broadcasting Company's studios in Hollywood. The next morning the group assembled early and boarded a special bus for the day's trip, which covered the various government projects in the Los Angeles County Flood Control District. The tour was conducted by Lieutenant Milwit, of the

MEMBERS AND GUESTS OF SAN DIEGO SECTION VISIT HAINES CANYON DEBRIS DAM

Corps of Engineers, U. S. Army, who explained the various projects. In the accompanying photograph the group, consisting of nine engineers and their lady guests, is pictured at the Haines Canyon Debris Dam, one of the projects visited.

Spokane Section

About 125 were present at the November 9 meeting of the Spokane Section, which was a joint session with the Student Chapters at Washington State College and the University of Idaho. This gathering was held at Moscow, Idaho, and the University of Idaho Student Chapter was in charge of all program arrangements. William Pierce, president of that Student Chapter, introduced the speakers, the list including W. P. Hughes, the Society's Contact Member for the Chapter. The principal address was given by Theron D. Weaver, district engineer for the Corps of Engineers, U. S. Army, at Bonneville, Ore. Major Weaver explained the activities of the army engineers and then showed interesting pictures of the Bonneville Project.

Syracuse Section

The first fall meeting of the Syracuse Section was held on October 31, with E. C. Lawton, assistant commissioner of highways for the New York State Department of Public Works, as guest

speaker. There were 139 present to hear Mr. Lawton's address, which was on the subject of highway safety. Preceding the meeting, the Section entertained at a dinner for Mr. Lawton.

Tacoma Section

The November meeting of the Tacoma Section took place at the Hotel Olympian in Olympia. During the business session a number of Section matters were discussed, and the report of the nominating committee was presented. Two technical speakers were then introduced and gave an interesting presentation of highway economics, traffic control, and traffic problems. These were Bertram H. Lindman, engineering economist for the Highway Transportation Commission, and Carl Fritts. Considerable discussion of their talks followed.

Tennessee Valley Section

At the annual meeting of the Tennessee Valley Section (reported in the December issue of Civil Engineering), the following officers were elected for the coming year: Lee G. Warren, president; J. L. Lamson, J. I. Perrey, A. S. Fry, and P. B. Hill, vice-presidents; and C. B. Coe, secretary-treasurer.

Virginia Section

On October 22 the fall meeting of the Virginia Section was held at Lexington, where the members were guests of the Virginia Military Institute Student Chapter. This all-day session consisting of a technical meeting, an afternoon of football, and a social evening was reported in the "Student Chapter Notes" department of the December issue.

West Virginia Section

The fall meeting of the West Virginia Section took place at the Chancelor Hotel in Parkersburg on October 27, with 21 present. Following an address of welcome, given by Roland P. Davis, Director of the Society and dean of the college of engineering at West Virginia University, there was a business meeting. During this session Thomas F. Boltz was elected president; no other offices were open to election at this time. It was also moved and seconded that the Section establish an annual prize of junior membership in the Society for the civil engineering student at West Virginia University who qualifies scholastically and is approved by the faculty. A technical program concluded the meeting. The speakers appearing on this program were K. S. Watson, chemical engineer for the State Water Commission, and K. A. Kettle, chief draftsman for the Carbide and Carbon Chemicals Corporation.

Wisconsin Section

A number of distinguished guests were present at the joint meeting of the Wisconsin Section and the University of Wisconsin Student Chapter, which was held at Madison on November 8. These included Frederick E. Turneaure, Honorary Member of the Society, and dean emeritus of the college of mechanics and engineering at the university, and Daniel W. Mead, Past-President and Honorary Member of the Society. Brief reports on the Local Sections Conference held at the Rochester Meeting were given, and several announcements were made. The speaker of the evening was a representative of the Chain Belt Company, who gave an interesting illustrated talk on "pumpcrete." Considerable discussion followed. James L. Ferebee, official nominee for Vice-President of the Society, discussed the relationship of the Local Sections to the Society, and Dr. Mead spoke on the value of membership in the Society to the engineer. The total attendance of 165 included 75 members of the University of Wisconsin Student Chapter.

Alfred Noble Prize for 1938 Awarded

Announcement is made by the Joint Committee on the Alfred Noble Prize, with the approval of the Society's Executive Committee, of the selection of the winner of the prize for 1938. The award is to go to Ralph J. Schilthuis, member of the American Institute of Mining and Metallurgical Engineers, for his paper on "Connate Water in Oil and Gas Sands," published in the 1938 issue of *Petroleum Technology*. The prize will be presented to the recipient at the annual dinner of the American Institute of Mining and Metallurgical Engineers, to be held in New York City on February 15, 1939.

Mr. Schilthuis is in the production research department of the Humble Oil and Refining Company, of Houston, Tex., where he went in 1930, following his graduation from the Colorado School of Mines.

The recipient of the Alfred Noble Prize is selected by a committee of five, consisting of one representative from each of the four Founder Societies and the Western Society of Engineers. The award is based upon papers published by the various cooperating societies in the twelve months preceding June 1 of each year (instead of the twelve months preceding July 15, as formerly), and is made to a member of any grade of any of these societies for a technical paper of special merit accepted by the publication committee, provided the author, at the time the paper is accepted in practically its final form, is not over thirty years of age.

The prize was established in 1921 for the purpose of perpetuating the name and achievements of Alfred Noble, Past-President of the Society and of the Western Society of Engineers. In addition to a $500 cash award, the recipient receives a certificate signed by the President and Secretary of the American Society of Civil Engineers (which acts as trustee of the fund), bearing the names of the various societies participating. The certificate is accompanied by a letter stating significant facts relating to the life and works of Alfred Noble.

The award to Mr. Schilthuis is the sixth made to date. In 1933 it went to a civil engineer, Claude Maxwell Stanley, Jr., at that time Jun. Am. Soc. C.E., for his paper, "Study of Stilling Basin Design," published in the 1932 volume of Proceedings.

This year, for the first time since the establishment of the prize, an honorable mention was given. This went to E. C. Huge, of Barberton, Ohio, for his paper entitled "Experimental Investigation of Effects of Equipment Size on Convection Heat Transfer and Flow Resistance in Cross Flow of Gasses Over Tube Banks." Mr. Huge is a member of the American Society of Mechanical Engineers.

Student Chapter Notes

Louisiana State University

The Louisiana State University Student Chapter reports that an active and interesting year is under way. On October 21 the members enjoyed a joint meeting with the Louisiana Section, which was reported in the "News of Local Sections" department

Members of Louisiana State University Student Chapter

of the December issue of Civil Engineering. On November 10 the Chapter sponsored the showing of a five-reel motion picture entitled "The New Story of Ancient Wrought Iron." This affair was appreciated by a number of members and guests. Members of the Chapter are shown in the accompanying photograph.

Virginia Military Institute

In November members of the Virginia Military Institute Student Chapter enjoyed two regular meetings, with a total attendance of 320. On November 4 the program was in the hands of students, whose talks covered such diverse subjects as landscaping, a trip to South America, and work in a tobacco market. At the session held on the 26th, the Chapter was fortunate in having as its principal speaker, Captain Weiss, former explorer and German army officer, who recounted some of his experiences as a trader in Africa.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for February

Among the not-too-easy ways of earning a living is the business of submarine diving. Those attending the Annual Meeting Smoker in January will hear Captain John Craig's personal account of some of its more thrilling aspects. Back home again, a week or so later, the February issue of Civil Engineering will bring them a story of the every-day engineering uses of diving—its applications to deep-water construction. It is told by Arthur Elliott, formerly engineer of submarine inspection on the San Francisco–Oakland Bay Bridge. As Mr. Elliott points out, when a diver is hired the primary objective is to have him do his job efficiently and without any mishaps—and to accomplish this objective his employer should know just what the man under water is up against and what he can reasonably be expected to accomplish.

Another article scheduled for the February issue also goes to the bottom of things. E. J. Christenson's contribution describes the compacting of a dam foundation by pile-driving operations. "Many structures," he says, "must be built on newly placed fills, and this fact necessitates the compaction of the fill as much as possible prior to construction. Such a condition existed at Lock and Dam No. 3 on the Mississippi River, where a 15-ft layer of silt had been removed and replaced (by dredging) with suitable sand in a very unstable state." His article includes an explanation of the methods used to determine the degree of compaction obtained.

Entrainment of air in swiftly flowing water is an important factor in the design of overfall spillways and steep chutes, since it increases the volume of flow for which provision must be made. E. W. Lane has given considerable thought to this problem, and will present the conclusions of his research.

Other articles in February will be selected from a variety of fields. Among them will be several papers from the program of the Annual Meeting.

A.S.A. Elects New Officers

At the annual meeting of the American Standards Association, which was held in New York City on November 30, Edmund A. Prentis, M. Am. Soc. C.E., was elected president. Mr. Prentis is a member of the New York engineering firm of Spencer, White and Prentis, Inc.

The other officers elected at this time were R. E. Zimmerman, of Pittsburgh, vice-president; F. M. Farmer, of New York, chairman of Standards Council; and R. P. Anderson, also of New York, vice-chairman of Standards Council.

Notable Honors Come to Society Members

In the past few weeks word has reached Society Headquarters of several members recently honored in diverse ways for outstanding service to the profession.

John F. Stevens, Past-President and Honorary Member of the Society has been selected as the third recipient of the Hoover Medal. The Medal will be presented to Mr. Stevens on January 18, 1939, during the Annual Meeting of the Society, with the following citation: "John Frank Stevens, engineer of great achievement as illustrated in his work on the Panama Canal who, in his dealings with the Inter-Allied Forces in Siberia in the Great War, demonstrated those broader capacities for humanitarian public service beyond his calling, which have earned for him the recognition of the Hoover Medal for 1938."

Engineering service on a number of railroads in the Northwest engaged Mr. Stevens' earliest efforts. In 1905 he was appointed chief engineer of the Panama Canal and, later, was chairman of the Isthmian Canal Commission. From 1907 to 1917 he again engaged in railroad work, being president of several West Coast railroads. In the latter year he went to Siberia at the request of the Kerensky government as chairman of its commission of railway experts. He remained there for six years, becoming in 1919 president of the Inter-Allied Technical Board, with headquarters at Harbin, Manchuria. After Mr. Stevens' return to the United States in 1923, he engaged in consultation work on railroad problems.

He was elected an Honorary Member of the Society in 1922, and served as President in 1927. He has been awarded the

John F. Stevens

John Fritz Medal, the United States Distinguished Service Medal, and the Gold Medal of the Franklin Institute.

The Hoover Medal was established in 1930 during the celebration of the fiftieth anniversary of the American Society of Mechanical Engineers, to commemorate the achievements of former President Herbert Hoover, to whom the first award was made. The second recipient was the late Ambrose Swasey. Thus all three medallists have been Honorary Members of the Society.

On October 25 honorary membership in the Chicago Engineers Club was conferred on Theodore L. Condron, M. Am. Soc. C.E., who since 1901 has been in private practice in Chicago as a bridge and structural engineer. From 1912 to 1924 he was president of the Condron Company, and since 1924 he has been a member of the firm of Condron and Post. His firm

Theodore L. Condron

has designed many factories, bridges, and warehouses and has acted in a consulting capacity to numerous large industrial organizations, including the General Electric and the Ford Motor companies.

Mr. Condron is a member of many engineering societies, and in 1905 he was awarded the Chanute Medal of the Western Society of Engineers. He has also been active in Society affairs, having served as Director from 1923 to 1925.

(On the same occasion as Mr. Condron, Edward Haupt, M. Am. Soc. C.E., was similarly honored by the Chicago Engineers Club. The Haupt award was reported in the December issue of Civil Engineering, but information available at that time appeared to indicate that Mr. Condron was already an honorary member of the club.)

The honorary degree of doctor of engineering was recently conferred on J. B. Challies by his alma mater, the University of Toronto. Dr. Challies, long a member of the Society, is a Canadian, and president of the Engineering Institute of Canada. Before the World War he was chief of the water power branch of the Department of the Interior, Dominion Civil Service. Later this developed into the Water Resources Branch, of which he became director.

Dr. Challies retired from government service to become a departmental manager of the Shawinigan Water and Power Company, and later was made assistant

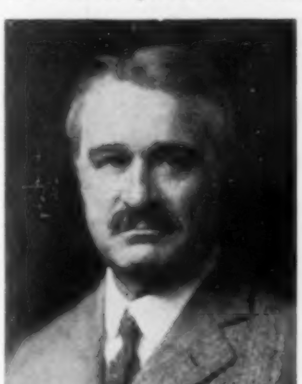
general manager. He is recognized as an authority on the conservation of water power resources, especially in their international significance.

J. B. Challies

Two other members of the Society have been honored by having their names given to important structures in recognition of their engineering work. These are Elmo G. Harris, professor emeritus of civil engineering at the Missouri School of Mines and Metallurgy, and Caleb Mills Saville, manager and chief engineer of the Metropolitan (Hartford, Conn.) District Commission.

Elmo G. Harris

On November 14 the Missouri School of Mines laid the cornerstone of Harris Hall, an engineering building, which is being named for Professor Harris in recognition of his forty years as professor of civil engineering at the school. Professor Harris went to Rolla in 1891 and retired with the title of professor emeritus in



Caleb M. Saville

1931. He is noted for his outstanding contributions to the science and practice of hydraulics and compressed air as well as for his activities in the teaching field.

The new dam of the Hartford, Conn., Metropolitan District at Barkhamsted, Conn., will be renamed Saville Dam in honor of Mr. Saville, for 26 years manager and chief engineer of the District's water bureau. This action was taken by unanimous vote of the commission in recognition of Mr. Saville's "conception and planning, both in engineering and fiscal measures, that has extended the District system to its present size." The structure, now known as Bill's Brook Dam, is the largest in the state. In 1914 Mr. Saville was awarded the Society's Norman Medal.

It will be recalled that the December issue of Civil Engineering carried an announcement of the appointment of Lawrence M. Lawson, M. Am. Soc. C.E., as arbiter for the United States in the land dispute with Mexico. At the time the item was prepared no photograph of

Lawrence M. Lawson

Mr. Lawson was available. Civil Engineering is glad to be able to include one now in this group of members recently honored.

Registration of Contractors Required in Virginia

Registration of contractors doing business in Virginia will be required after January 1, 1939, under an act passed by the last General Assembly of that state. The State Registration Board for Contractors, which is to administer the act, is charged with the responsibility of ascertaining the past performance record of each applicant and his reputation for paying his labor and material bills. It may require the applicant to furnish evidence of his ability, character, and financial responsibility, and may also require him to submit to a written or oral examination.

Engineers and architects preparing plans are required to state in their invitations to bidders and in the specifications for work contracted in Virginia, notice to the effect that registration is required under the Act (with certain exceptions) before their bids can be received. Copies of the law and regulations are being sent from Society Headquarters to the secretaries of all Local Sections, through the courtesy of Charles P. Bigger, executive secretary of the registration board.

NEWS OF ENGINEERS

Personal Items About Society Members

Edwin F. Wendt has moved his consulting practice from Washington, D.C., to Pittsburgh, Pa., where he will continue to specialize in transportation problems.

Hugh H. Schmidt recently left the Central Nebraska Public Power and Irrigation District at Gothenburg, Nebr., to become an instrumentman for the International Boundary Commission, with headquarters at San Benito, Tex.

George J. Willier is now an engineer for the Federal Power Commission, in Washington, D.C. He previously held a similar position with the Sheffield Steel Corporation, of St. Louis, Mo.

H. Alden Foster has resigned from the engineering staff of the New York World's Fair, Inc., where he was chief of engineering design, in order to return to the office of Parsons, Klapp, Brinckerhoff and Douglas, consulting engineers of New York.

O. H. Koch, consulting engineer of Dallas, Tex., has been appointed by the U. S. Housing Authority to be the city planning consultant in regard to site locations for all the slum-clearance projects in the state of Texas.

David C. Filley, formerly junior civil engineer for the Humble Oil and Refining Company, of Tyler, Tex., has taken a position as area engineer for the National Youth Administration at Cleburne, Tex.

F. S. Glynn, Jr., is now doing concrete control work for the Virginia Electric and Power Company at Richmond, Va. Last year he was working for Stone and Webster in the architectural school at Massachusetts Institute of Technology.

Harold P. Brooks, until lately in the Columbus (Ohio) office of the U. S. Geological Survey, has been transferred to the District Engineer's Office of the Survey in Topeka, Kans., where his duties consist of office and field work in connection with stream-gaging stations throughout the state of Kansas.

John W. Wheeler has been appointed assistant chief engineer of the Burlington Lines, with headquarters in Chicago, Ill. He was formerly engineer of highway negotiations.

Alfred W. Garnell has resigned from the U. S. Bureau of Reclamation at Denver, Colo., to accept a position as assistant engineer in the U. S. Engineer Office at Providence, R.I.

Harry M. Reeves has been transferred from the Tennessee Valley Authority at Knoxville, Tenn., to the Federal Power Commission in Washington, D.C.

Robert E. Rathburn, of Detroit, Mich., is now an instructor in the University of Colorado.

W. G. McFarland, previously designing engineer for Madigan-Hyland, of New York City, has become connected with

Purdy and Henderson Associates, Inc., of the same city.

JOSHUA D'ESPOSITO has been appointed to represent the PWA as resident project engineer on Chicago's subway project. He will continue to serve as resident projects engineer for the Sanitary District of Chicago.

T. T. MCCROSKY is now in the department of city planning of the New York City Planning Commission, with headquarters in the Municipal Building, New York. He was formerly project adviser for the U. S. Housing Authority in Washington, D.C.

J. L. BURKHOLDER has announced his resignation as assistant general manager of the Metropolitan Water District of Southern California in order to assume new duties as chief of the division of engineering, American section, of the International Boundary Commission, with headquarters at El Paso, Tex. For the past six years Mr. Burkholder has been in direct charge of all construction work on the main line of the Colorado River Aqueduct.

CLAUDE J. ROGERS is now assistant highway engineer of Jefferson County, Alabama. He will supervise work on WPA projects sponsored by the county.

GLENN S. BURRELL, captain, CEC, U. S. Navy, has been transferred from Pensacola, Fla., where he was public works officer, to the Norfolk (Va.) Navy Yard. He will continue to serve in the same capacity.

JOHN W. JOHNSON, until recently assistant assessor for the city of Buffalo, N.Y., has been appointed assistant works superintendent at the Bird Island sewage treatment plant in that city.

EDWIN H. MARKS, lieutenant-colonel, Corps of Engineers, U. S. Army, has been made division engineer of the Ohio River Division, with headquarters at Cincinnati, Ohio. Previously Colonel Marks was district engineer at Buffalo, N.Y.

DECEASED

EDWIN PERCIVAL ARNESON (M. '32) civil engineer of San Antonio, Tex., died there on December 7, 1938, at the age of 50. At the time of his death Mr. Arneson was a Director of the Society, and his term would have expired in January 1939. A sketch of his career appears in the "Society Affairs" department of this issue.

EDWARD LEE BANDY (M. '23) PWA engineer at Bruceton, Tenn., died there on November 7, 1938, at the age of 55. After six years in engineering work in the Panama Canal Zone, Mr. Bandy maintained a consulting practice in Memphis, Tenn. Later he was district highway engineer in New Mexico and Louisiana, and from 1936 on he was resident engineer inspector for the PWA—at Hartsville, Tenn., El Dorado, Ark., and finally at Bruceton.

JOHN ARTHUR BRYANT (M. '25) treasurer of Bryant and Detwiler Company, of Detroit, Mich., died in that city on November 15, 1938, at the age of 57. A native of New York State, Mr. Bryant went to Detroit in 1902. He was one of the founders of the construction firm of Bryant and Detwiler Company, which erected many of Detroit's large buildings, including the Ford and Packard plants and the Detroit Institute of Fine Arts. At the time of his death Mr. Bryant was also vice-president of the Ferro Stamping and Manufacturing Company.

EDWARD ABRAHAM BYRNE (M. '18) of Brooklyn, N.Y., an original sponsor of the Triborough Bridge, died in Rye, N.Y., on December 6, 1938. He was 74. Mr. Byrne was in the employ of the City of New York for forty-seven years—part of the time (1916 to 1933) as chief engineer of the Department of Plant and Structures. He was the planner and earliest advocate of the Triborough Bridge, and in 1933 and 1934 was chief engineer of the Triborough Bridge Authority. Mr. Byrne was also the designer of the 233d Street Viaduct and had acted in a consulting capacity in the engineering work for the Holland Tunnel and the Delaware River Bridge.

CORNELIUS MARK DAILY (M. '17) vice-president of the Missouri Engineering and Contracting Company, of St. Louis, Mo., died on November 25, 1938, at Jacksonville, Ill., where he had been supervising a water-works improvement project. He was 62. In 1913, after several years in government and private work, Mr. Daily became connected with the St. Louis Water Department. In 1925 he left the city service to join the Missouri Engineering and Construction Company, but resigned in 1933 to become water commissioner of St. Louis. Three years later he reentered private business.

HOWELL TRACY FISHER (M. '13) civil engineer of Philadelphia, Pa., died on November 6, 1938, at the age of 77. Mr. Fisher's early career included experience with the U. S. Board of Engineers on Deep Waterways and the Isthmian Canal Commission as well as numerous other organizations. From 1903 to 1909 he was assistant engineer for the Pennsylvania, New York and Long Island Railroad on subaqueous tunnel work, and later he was for some time tunnel engineer for Mackenzie Mann and Company, Ltd., of Montreal, Canada, on design and construction of a tunnel, terminal, and track for the Canadian Northern Railway.

HANS JORGEN HANSEN (M. '19) office engineer in charge of bridge design for the Chicago, Milwaukee, St. Paul and Pacific Railroad Company, died suddenly on November 4, 1938, at the age of 67. A native of Denmark, Mr. Hansen came to this country in his youth and was educated at the Armour Institute of Technology. In 1906, after considerable experience with bridge construction firms, he entered the service of the Chicago, Milwaukee, St. Paul and Pacific Railroad Company as a draftsman. He was promoted to squad foreman in 1915, and to office engineer in 1917.

JAMES NOBLE HATCH (M. '04) retired consulting engineer, died at his home in Alameda, Calif., on November 11, 1938, at the age of 70. Mr. Hatch's early experience included college teaching and engineering work with the Carnegie Steel Company. From 1903 to 1914 he was structural engineer for Sargent and Lundy, of Chicago, and from the latter year until 1927 he maintained a consulting practice in Chicago. Mr. Hatch then retired to his native state, California, where he devoted himself to writing. He is well known for his poems on engineering, published under the pen name of "Truthful James."

HURLBUT SMITH JACOBY (M. '22) director of industrial research and field director of the Engineering Experiment Station at Ohio State University since 1934, died in Columbus, Ohio, on November 16, 1938. He was 52, the son of Prof. Henry S. Jacoby, M. Am. Soc. C.E., and father of Hurlbut Saylor Jacoby, Jun. Am. Soc. C.E. For several years Mr. Jacoby was professor of structural engineering at Pennsylvania State College, and he also served as engineer for a number of firms, including the McClintic-Marshall Company and the H. K. Ferguson Company. Preceding his appointment to the staff of Ohio State University, he was working on federal engineering projects in Washington, D.C.

JOHN FRANCIS MCFARLIN (Affiliate '34), owner of the Southern Asphalt Construction Company, of Miami, Fla., died on December 1, 1938, at the age of 52. From 1919 to 1924 Mr. McFarlin was general superintendent of the W. M. Keesecker Contracting Company; from 1924 to 1926, general manager of the Buckeye Company, Inc.; and from 1926 to 1928, vice-president and general manager of the Phoenix Asphalt Construction Company. In the latter year he became general manager of the Southern Asphalt Construction Company, of which he was later made owner.

ROBERT RIDGWAY, Past-President and Honorary Member of the Society and consulting engineer of New York City, died in Fort Wayne, Ind., on December 19, 1938, at the age of 76. Mr. Ridgway was en route from Chicago to his home in New York when stricken. A sketch of his career appears in the "Society Affairs" department of this issue.

VERNON LYLE SULLIVAN (M. '13) district engineer for the Red Bluff Water Power Control District at Pecos, Tex., died recently at the age of 62. Mr. Sullivan was city engineer of Carlsbad, N.Mex., in 1905 and 1906; territorial engineer of New Mexico from 1907 to 1910; and engineer and manager for the Imperial Irrigation Company, Buenavista, Tex., from 1911 to 1921. Later he maintained a consulting practice at El Paso, Tex., for some years, and in 1937 became district engineer for the Red Bluff Water Power Control District.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From November 10 to December 9, 1938, Inclusive

Additions to Membership

Arendts, Eldron Charles (Jun. '38), Care, Hydr. Section, U. S. Engr. Office, Rock Island, Ill.

Ayers, James Robert, Jr. (Assoc. M. '38), Asst. Structural Engr., Bureau of Yards and Docks, Navy Dept., Washington, D.C. (Res., 4627 Third St., South, Arlington, Va.).

Bailey, Steele (Assoc. M. '38), Res. Engr., Shoecraft, Drury & McNamee, Water Works, Flint, Mich.

Baird, James Adam (Assoc. M. '38), Asst. Chf. Engr., State Highway Dept., Montgomery, Ala.

Barber, Charles Merrill (Assoc. M. '38), Cons. Structural Engr., Socony-Vacuum Oil Co., 2341 Carnegie Ave., Cleveland, Ohio.

Barber, John Thomas (Jun. '38), Apartado 246, Caracas, Venezuela.

Barnes, Chiles Manly (Assoc. M. '38), Structural Designer, Suchar Process Corporation, 120 Wall St., New York (Res., 36–01 Thirty-first Ave., Astoria), N.Y.

Barratt, Herbert John (Jun. '38), Engr., British Columbia Pulp & Paper Co., Ltd., Woodfibre, B.C., Canada.

Basse, Arno (Jun. '38), Rodman, State Highway Dept., Div. 20, Beaumont, Tex.

Bastian, Mary Clarissa (Jun. '38), 102 State St., Charlevoix, Mich.

Baty, Walter Mark (Jun. '38), 347 Koons Ave., Buffalo, N.Y.

Beech, Daniel Raymond (Jun. '38), 134 Boulevard, Pittsburgh (10), Pa.

Bethel, John Southworth, Jr. (Jun. '38), 55 West Boylston St., Watertown, Mass.

Bethune, Roderick Arnett (Assoc. M. '38), Asst. Field Representative, RFC, 110 East 3d St., Little Rock, Ark.

Bickford, Kenneth Kevin (Jun. '38), Junior Bridge Engr., San Francisco–Oakland Bay Bridge, 500 Sansome St. (Res., 2090 Fell St.) San Francisco, Calif.

Bond, Richard Guy (Jun. '38), Asst., Dept. of Civ. Eng., Univ. of New Hampshire, Durham (Res., Bartlett), N.H.

Bowers, Douglas Albert (Jun. '38), Road Life Asst., Statewide Highway Planning Survey, State Highway Comm. (Res., 1618 North West 11th St.), Oklahoma City, Okla.

Bowman, Don Ceylon, Jr. (Jun. '38), 8235 Washington St., St. Louis County, Mo.

Bridgewater, Carroll Calvin (Jun. '38), Box 1812, Conchas Dam, N.Mex.

Briggs, Arthur Allen (Jun. '38), 607 Ave. C, S.E., Childress, Tex.

Brooks, Jack Dickerson (Jun. '38), 1930 Ivanhoe, Denver, Colo.

Brown, Russell Hayward (Jun. '38), 223 Temple St., West Roxbury, Mass.

Burk, John Skyburn (Jun. '38), 7831 Plum St., New Orleans, La.

Butler, Morgan Robert, Jr. (Jun. '38), 154 Wisconsin Ave., Waukesha, Wis.

Cami, Roy Morgan (Jun. '38), CCC Camp, D-5, Thibodaux, La.

Campbell, Joseph Francis (Jun. '38), Insp. on Constr., Bridge Dept., State Highway, Mount Pleasant, S.C.

Carlock, Howard Joseph (Jun. '38), 101 West 91st St., New York, N.Y.

Carnegie, Orris Alvin (Jun. '38), Route 1, Albany, Ore.

Chandler, William Reeder (Jun. '38), Care, California Arabia Standard Oil Co., Bahrein Island, Persian Gulf.

Chapman, Robert Breckinridge, III (Jun. '38), 2421 Maryland Ave., Baltimore, Md.

Cheney, Lloyd Theodore (Jun. '38), 222 Warren Sq., Bethlehem, Pa.

Chew, Richard Sanders (M. '38), Cons. Engr., 844A Mills Bldg., San Francisco, Calif.

Chiarito, Patrick Theodore (Jun. '38), 136 Columbia Ave., Hampton, Va.

Clark, Byron James (Jun. '38), Junior Engr. (Civ.), U. S. Engr. Dept. (Res., 6316 Thirty-second Ave., N.W.), Seattle, Wash.

Cloues, Richard Wenuell (Jun. '38), 1151 Willow Branch Ave., Jacksonville, Fla.

Cocchiarella, Otell Mario (Jun. '38), 364 South 7th St., Newark, N.J.

Compton, August Walter (Jun. '38), Asst. Engr., Eng. Dept., City of East Cleveland, 218 Auditorium Bldg., Cleveland, Ohio.

Corbin, Keith Marcus (Jun. '38), Care, Constr. Products Co., 505 Finance Bldg., Kansas City, Mo.

Cornelissen, Hendrik (Jun. '38), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

Cornell, Holly Adams (Jun. '38), 51 Prospect St., New Haven, Conn.

Cornett, Roy Charles (Jun. '38), 516 Mabel St., Chattanooga, Tenn.

Crawford, Clark Alvin (Jun. '38), Graduate Asst., Research Foundation, Armour Inst. of Technology, Chicago, Ill.

Crooker, John Twiname (Jun. '38), Bin XX, Taft, Calif.

DeLong, Lawrence Merton (Jun. '38), 3291 South West Fairmount Boulevard, Portland, Ore.

Dixon, Arthur Evans (Jun. '38), 729 West 8th St., Los Angeles, Calif.

Drake, Gilbert George (Jun. '38), 2025 Eighth Ave., North, Seattle, Wash.

Drake, Harry Laurin (Jun. '38), Eng. Aide, U. S. A. Engrs., Woodward, Okla.

Duberstein, Philip (Jun. '38), With WPA (Res., 536 West 111th St.), New York, N.Y.

Durfee, Charles Densmore, Jr. (Jun. '38), 516 Mabel St., Chattanooga, Tenn.

Edelen, George Wathen, Jr. (Jun. '38), Asst. Engr., Div. of Water Resources, State Board of Agriculture, State House (Res., 209 Western Ave.), Topeka, Kans.

Erickson, Edwin Milton (Jun. '38), 625 Ovington Ave., Brooklyn, N.Y.

Feldhake, Clarence John (Jun. '38), 747 North Elizabeth St., Lima, Ohio.

Fenstermaker, Charles Howard, Jr. (Jun. '38), 833 Wood St., Houma, La.

Fields, Kenneth E. (Jun. '38), Lieut., U.S.A., 50 Poplar St., Belmont, Mass.

Fleck, Kenneth James (Jun. '38), Civ. Engr., Caterpillar Tractor Co. (Res., 210 West Armstrong), Peoria, Ill.

Foard, Charles Mann (Jun. '38), 5502 Arabia Ave., Baltimore, Md.

Garbe, Ralph Roy (Jun. '38), Junior Hydr. Engr., SCS, Box 205, Safford, Ariz.

TOTAL MEMBERSHIP AS OF DECEMBER 9, 1938

Members	5,663
Associate Members	6,246
Corporate Members	11,909
Honorary Members	28
Juniors	3,761
Affiliates	75
Fellows	1
Total	15,774

Gammie, Thomas George (Assoc. M. '38) Engr.-Director, Div. of State Planning, 601 State Capitol, Oklahoma City, Okla.

Garratt, John Nathan (Jun. '38), 40 Sylvan Pl. Nutley, N.J.

Gaul, John Wilcox (Jun. '38), 508 Highland Rd., Ithaca, N.Y.

Geffel, John Charles (Jun. '38), 197 Shetland Ave., Pittsburgh, Pa.

Gentilich, John Stone (Jun. '38), Junior Engr. with Director, U. S. Waterways Experiment Station, Vicksburg, Miss. (Res., 1338 Almonaster Ave., New Orleans, La.)

Gibson, William Murel (Assoc. M. '38), Chf. of Party, Sponsor Representative, U. S. Coast and Geodetic Survey, Div. of Geodesy, New York (Res., 8310 Thirty-fifth Ave., Jackson Heights), N.Y.

Girand, John Goodman (Assoc. M. '38), Designing Engr., James B. Girand, 405 Ellis Bldg., Phoenix, Ariz.

Goeke, Harold Everett (Jun. '38), Aluminum Club, New Kensington, Pa.

Gomez, Amalio (Jun. '38), 959 Jackson St., San Francisco, Calif.

Grant, Francis Weir (Jun. '38), With Eng. Dept., City of Shreveport (Res., 525 Rutherford St.), Shreveport, La.

Green, Arthur Henry (Jun. '38), 1103 North Fulton, Fresno, Calif.

Guppy, John Lechmere (Assoc. M. '38), With Chas. McEnearny & Co., Ltd. (Res., 31 St. Vincent St.), Port of Spain, Trinidad.

Hall, Frederic Francis (M. '38), Structural Engr. (Hall & Pregnoff), 350 California St., San Francisco, Calif.

Harstad, Howard Theodore (Jun. '38), Route 3, Box 270, Puyallup, Wash.

Hechmer, William Louis (Jun. '38), 2904 Eighteenth St., N.W., Washington, D.C.

Hechtman, Robert Aaron (Jun. '38), 4858½ Rainier Ave., Seattle, Wash.

Hilderman, Richard Alan (Jun. '38), 293 East Ave., Lockport, N.Y.

Holbrook, Wallace Ellsworth (Jun. '38), 626 West Alabama St., Houston, Tex.

Hveem, Francis Nelson (Assoc. M. '38), Senior Physical Testing Engr., Materials and Research Dept., State Div. of Highways, 3435 Serra Way, Sacramento, Calif.

Jacobson, Randolph Norman (Jun. '38), 111 Garrison Ave., Evanston, Ill.

Jarvi, Albert Otto (Jun. '38), 512A Graduate House, Mass. Inst. Tech., Cambridge, Mass.

Johnson, Chester Herman (Jun. '38), Supt. of Buildings and Grounds, Washburn Coll., Topeka, Kans.

Johnson, Francis Joseph (Jun. '38), Junior Draftsman, Roadway Planning Dept., State Highway Comm. (Res., 217 East North St., Apartment 104), Raleigh, N.C.

Karr, Horace Mitchell (Jun. '38), Draftsman, Shell Development Co., 100 Bush St., San Francisco, Calif.

Kennedy, Robert Malcolm (Jun. '38), Atlas Bldg., 604 Mission St., San Francisco, Calif.

Khalifa, Mohamed Kamal (Jun. '38), 32 Mellen St., Cambridge, Mass.

Kile, Fred James (Jun. '38), 1502 White Ave., Beloit, Wis.

Kissgen, Val Earhart (Jun. '38), 916 Aline St., New Orleans, La.

Kite, Maurice Burton (Jun. '38), Asst. Structural Engr., TVA, 118 James Bldg. (Res., 1305 Normal Ave.), Chattanooga, Tenn.

Klasing, Waldemar John (Jun. '38), 3197A Portis Ave., St. Louis, Mo.

Kleban, Theodore (Jun. '38), R.F.D. 1, Box 145 N, Rahway, N.J.

Koretsky, Sanford (Jun. '38), 545 West 158th St., New York, N.Y.

KRABBENHOFT, CLIFFORD RAY (Jun. '38), Junior Engr., State Highway Comm., 1409 Topeka Boulevard, Topeka, Kans.

LANDAU, THOMAS JACOB (Jun. '38), 125 First Ave., Pittsburgh, Pa.

LANIER, EUGENE BERTRAM (Jun. '38), 304 North Walnut St., Pittsburg, Kans.

LEHAMN, FREDERICK GOODWIN (Jun. '38), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

LENDECKE, HUGO ROBERT (Assoc. M. '38), Res. Engr., Bridge Dept., State Div. of Highways, 1229 South Shelton St., Santa Ana, Calif.

LESLIE, ALEXANDER (Jun. '38), Asst. Engr., Messrs. J. & A. Leslie & Reid, 72a George St., Edinburgh, 2 (Res., 5 Douglas Gardens, Edinburgh, 4), Scotland.

LEVIEN, MAURICE BERYL (Jun. '38), 170 West 73d St., New York, N.Y.

LINDEMAN, MARVEL FRED (Assoc. M. '38), Instr., Civ. Eng., Coll. of Eng., Wayne Univ., Detroit, Mich.

LIPMAN, ROBERT CHARLES (Jun. '38), 624 Foss Ave., Drexel Hill, Pa.

LIPTON, SAMUEL (Jun. '38), 1922 Bent Ave., Cheyenne, Wyo.

LORENZ, GILBERT GUSTAV (Jun. '38), Junior Engr., U. S. Engrs., U. S. Engr. Office, 300 Broadway, Little Rock, Ark.

LUNDIN, ALFRED LAWRENCE (Jun. '38), 215 West 98th St., New York, N.Y.

LYMAN, MELVILLE HENRY, JR. (Jun. '38), 119 Midland Ave., Glen Ridge, N.J.

MCCLARY, JAMES DALY (Jun. '38), Care, Morrison-Knudsen Co., Inc., Box 407, North Platte, Nebr.

MCCRODDEN, HOWARD JAMES (Jun. '38), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

MALCOLM, WILLIAM LINDSAY (M. '38), Prof., Civ. Eng., and Director, School of Civ. Eng., Cornell Univ., Lincoln Hall, Cornell Univ., Ithaca, N.Y.

MÉNDEZ JIMENEZ, ORLANDO RAMON (Assoc. M. '38), Field Supt., Puerto Rico Reconstruction Administration, Peñuelas, Puerto Rico.

MERRIMAN, WEYLAND (Jun. '38), Draftsman and Instrumentman, H. N. Roberts, Box 12, Pampa, Tex.

MILLENSIFER, ROBERT WILLIAM (Jun. '38), 4477 Wolff St., Denver, Colo.

MILLS, ARTHUR WILBUR (Jun. '38), 1144 North 4th St., Springfield, Ill.

MOHLER, CHESTER EDMOND (Jun. '38), 1746 Pennsylvania, Denver, Colo.

MOORE, ROBERT SCOTT (Jun. '38), 1832 Carey Pl., Oklahoma City, Okla.

MORGAN, CLIFFORD LEON (Jun. '38), 6021 Harper Ave., Chicago, Ill.

MORGAN, JACK CHARLES (Jun. '38), Asst. Instr., Fluid Mechanics, New York Univ. Box 125, New York Univ., University Heights, New York, N.Y.

MUNSON, GEORGE POINDEXTER, JR. (Jun. '38), Asst. Res. Engr., State Highway Dept., Mount Vernon, Tex.

MURRAY, FRANCIS ALOYSIUS (Assoc. M. '38), City Engr. (Res., 55 Parkview Terrace), Summit, N.J.

MYERS, FRANK COLBY (Assoc. M. '38), Draftsman, City of Oakland, Eng. Dept. (Res., 2525 Delmer St.), Oakland, Calif.

NACHAY, JOSEPH (Jun. '38), 1561 Fulton Ave., New York, N.Y.

OCKERBLAD, ANDREW MERRITT (M. '38), Associate Prof., Applied Mechanics, Univ. of Kansas (Res., 315 Mississippi), Lawrence, Kans.

OLSEN, LLOYD THOMAS (Jun. '38), Teaching Asst. in Civ. Eng., Graduate School of Eng., Harvard Univ., 53 Oxford St., Cambridge, Mass.

OPPENHEIM, LOUIS HERMAN (Jun. '38), Box 98, Pleasanton, Calif.

PETERS, DONALD CAMERON (Jun. '38), Junior Engr., Siesel Constr. Co. (Res., 4048 North Maryland Ave.), Milwaukee, Wis.

POTTER, JOHN CLAUDE, JR. (Jun. '38), 2d Lieut., Corps of Engrs., U.S.A., 1st Engrs., Fort Du Pont, Del.

POWELL, RICHARD LEIGH (Jun. '38), 4033 Cole Ave., Dallas, Tex.

PUTMAN, CLARENCE (Jun. '38), Fort Lincoln, Bismarck, N.Dak.

RADCLIFFE, JACK CLIFFORD (Jun. '38), San. Engr., Elizabethtown Water Co. (Res., 535 Trotters Lane), Elizabeth, N.J.

REDGRAVE, GILBERT RICHARD (Jun. '38), Asst. to Engr., Pennsylvania Flexible Metallic Tubing Co., Philadelphia (Res., 308 Vassar Ave., Swarthmore), Pa.

REILLY, JOSEPH THOMAS (Jun. '38), Eng. Aide (Civ.), Vicksburg Eng. Dist., Care, Y.M.C.A., Vicksburg, Miss.

REVELL, RUSSELL WHITTINGTON (Jun. '38), Care, Iowa Inst. of Hydr. Research, Iowa City, Iowa (Res., Bonanza, Ore.).

ROWLAND, SAMUEL JOHN (Jun. '38), Box 90, Vancouver, Wash.

SALMON, RICHARD (Assoc. M. '38), Chf. Engr. and Supt., The Foundation Co., Casilla 414, Oruro, Bolivia.

SANBORN, EDGAR FRANKLIN, JR. (Jun. '38), Draftsman, City of Cincinnati (Res., 2920 Woodside Pl.), Cincinnati, Ohio.

SCHAFER, ERNEST HENRY (Jun. '38), Box 1135, Mason City, Wash.

SCHLAX, WILLIAM FRANCIS (Jun. '38), 5333 Agatite Ave., Chicago, Ill.

SCHWAB, ALVIN RAYMOND (Jun. '38), 76 Oxford St., Cambridge, Mass.

SCOTT, RONALD FAIRBANKS (Jun. '38), With City Engr's. Office (Res., 1715 Ogden Ave.), Superior, Wis.

SHER, HYMAN HENRY (Jun. '38), 823 East Edgewater Rd., Los Angeles, Calif.

SIEBERT, GEORGE JOSEPH HAMEL (Jun. '38), 127 Merbrook Lane, Merion Station, Pa.

SJODAHL, SVEN ERIK (Jun. '38), Kellogg Hall, Battle Creek, Mich.

SMITH, LIVINGSTON SHATTUCK SALISBURY (Jun. '38), 51 Gillette St., Hartford, Conn.

SNOW, LOWBER DEBAUN (M. '38), Civ. Engr., Gulf Oil Corporation (Res., 2206 Woodhead St.), Houston, Tex.

SOLOMON, CHARLES BORDEN (Jun. '38), 965 Plymouth Ave., Fall River, Mass.

STEARNS, RAYMOND GUY (Jun. '38), Subsurveyman, U. S. Engrs. Office, Hydr. Section, Rock Island, Ill.

STEARNS, STEPHEN RUSSELL (Jun. '38), 223 Forster St., Harrisburg, Pa.

STEGMAIER, ROBERT BERNARD, JR. (Jun. '38), 3604 Forest Park Ave., Baltimore, Md.

SWATTA, FRANK ALBERT (Jun. '38), Officers Club, Fort Logan, Utah.

TATLOCK, MYRON WILSON (Assoc. M. '38), Supt., Sewage Treatment, City of Dayton (Res., 911 Ferndale Ave.), Dayton, Ohio.

TINNISWOOD, WILLIAM WALTER (Jun. '38), Care, Dept. of Civ. Eng., Univ. of Idaho, Moscow, Idaho.

TORRANCE, THOMAS CURTISS (Jun. '38), 51 Gillette St., Hartford, Conn.

TROWBRIDGE, GLENN HAROLD (Jun. '38), Coulee Dam, Wash.

TURNER, ROGER PARKHURST (Jun. '38), 713 East Powell St., Fort Worth, Tex.

VARGAS, CARLOS GUILLERMO (Jun. '38), Care, Socony-Vacuum Oil Co. de Colombia, Aguas Claras Camp, Santander, Colombia.

VAUBEL, ESTILLE ARTHUR (Assoc. M. '38), Engr., Layne Texas Co. (Res., 1959 Lexington Ave.), Houston, Tex.

WALKER, ALBERT ALVIA (Assoc. M. '38), Res. Engr., State Highway Dept., Div. 1, Box 262, Sherman, Tex.

WECKERLING, LEONARD EUGENE (Jun. '38), Junior Engr. "C," State Highway Design Dept., 1201 Kearney St., Manhattan, Kans.

WELCH, CLARENCE BENNING (Jun. '38), Graduate School of Eng., Harvard Univ., Pierce Hall, Harvard Univ., Cambridge, Mass.

WELSH, ROBERT EUGENE (Jun. '38), Draftsman, Erie R.R. (Res., 2014 Titus St.), Cleveland, Ohio.

WHISTON, NORMAN DAVIES (Jun. '38), 2418 Valley St., Omaha, Nebr.

WINTZ, WILLIAM ALOYSIUS, JR. (Jun. '38), Carville, La.

WITTE, EDWARD GEORGE (Jun. '38), Asst. Eng. Aide, TVA, 515 Union Bldg., Knoxville, Tenn.

WOODWARD, WALTER LEWIS (Jun. '38), Draftsman, State Highway Dept. (Bridge Dept.), 111 West 2d Ave., Cheyenne, Wyo.

YAYOSHI, MASAO (Jun. '38), 302 Fourteenth Ave. South, Seattle, Wash.

YOUNG, FRED OWEN (Assoc. M. '38), Asst. Engr. Insp., PWA, Box 2817, Honolulu, Hawaii.

ZUMWALT, PAUL LAWRENCE (Jun. '38), Emden, Ill.

MEMBERSHIP TRANSFERS

ALLEN, CHARLES WINSOR (Jun. '30; Assoc. M. '38), Asst. Engr., State Highway Testing Laboratory, Ohio State Univ. (Res., 180 West Weber Rd.), Columbus, Ohio.

BRIAN, LAWRENCE GORDON (Jun. '28; Assoc. M. '38), Designer, Checker, Standard Oil Co. of California, San Francisco (Res., 2746 Webster St., Berkeley), Calif.

CLAUS, THEODORE OTTO (Jun. '33; Assoc. M. '38), Senior Civ. Eng. Draftsman, Dept. of Public Works, City of Detroit (Res., 3987 Maybury Grand), Detroit, Mich.

COOKE, JOSEPH MALCOLM (Jun. '30; Assoc. M. '38), Associate Engr., Chf. of Design Section, U. S. Engr. Office (Res., 821 Eleventh St.), Huntington, W.Va.

COTTON, LINWOOD SUMNER (Jun. '28; Assoc. M. '38), Insp., Bridge Div., State Highway Comm., Augusta (Res., 71 Seavey St., Cumberland Mills), Me.

DILL, FREDERICK HAWES (Jun. '27; Assoc. M. '38), With Mech. Eng. Dept., Am. Bridge Co., Ambridge (Res., 619 Maple Lane, Sewickley), Pa.

FLETCHER, PHILIP NELSON (Jun. '32; Assoc. M. '38), Asst. Bridge Engr., San Francisco-Oakland Bay Bridge, 500 Sansome St., San Francisco (Res., 2535 Le Conte Ave., Berkeley), Calif.

HAGEDORN, HECTOR EDMUND (Jun. '37; Assoc. M. '38), Architectural Engr., Constr. Quartermaster, Office of the United States High Commr., Dewey Boulevard, Manila (Res., 13th St., New Manila, Rizal), Philippine Islands.

HILL, LELAND KERR (Jun. '35; Assoc. M. '38), Associate Civ. Engr., Appalachian Forest Experiment Station, U. S. Forest Service, 223 Federal Bldg., Asheville, N.C.

JOHNSON, ALBERT EDWIN (Assoc. M. '30; M. '38), Dist. Engr., U. S. Geological Survey, Water Resources Branch, 119 U. S. Court House, Columbia, S.C.

MCCLURE, THOMAS MERO (Assoc. M. '35; M. '38), State Engr., State Capitol, Santa Fe, N.Mex.

PARKIN, GEORGE THOMAS (Jun. '28; Assoc. M. '38), Designer, State Highway and Public Works Comm., Bridge Dept., Raleigh, N.C.

SCHREINER, NORMAN GEORGE (Jun. '28; Assoc. M. '38), Welding Engr., Linde Air Products Co., 30 East 42d St., New York, N.Y. (Res., 2516 North 17th St., Philadelphia, Pa.).

SMITH, KENNETH ALEXANDER (Jun. '27; Assoc. M. '38), Asst. Prof. of Architecture, School of Architecture, Columbia Univ., Avery Hall, Columbia Univ., Morningside Heights, New York, N.Y.

WAIDELICH, ALFRED THOMAS (Jun. '28; Assoc. M. '38), Engr., Estimating Dept., The Austin Co., 19 Rector St., New York (Res., 90-31 Whitney Ave., Elmhurst), N.Y.

WANG, WOODSON (Assoc. M. '35; M. '38), Chf. Designing Dept., Bureau of Hydr. Eng., National Economic Council, Nanking (Res., 25 Sheng Ping Chia, Moulmein Rd., Shanghai), China.

REINSTATEMENTS

VESTAL, WILLIAM BAXTER, Assoc. M., reinstated Dec. 7, 1938.

RESIGNATIONS

FALK, MYRON SAMUEL, JR., Jun., resigned Nov. 9, 1938.

FENELON, EARL STANLEY, Assoc. M., resigned Dec. 6, 1938.

GRANBERG, ROBERT JAMES, Jun., resigned Dec. 6, 1938.

LUSK, CHARLES BENTON, Jun., resigned Nov. 14, 1938.

MORRIS, JOHN HITE, Jun., resigned Dec. 6, 1938.

SARANIERO, EMIL JOSEPH, Jun., resigned Dec. 6, 1938.

SCOTT, CLAUDIUS BERNARD, Assoc. M., resigned Dec. 6, 1938.

ZEESE, ROBERT KENNETH, Jun., resigned Dec. 1, 1938.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

January 1, 1939 NUMBER 1

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

FOR MEMBER

DAVISON, JAMES GOLDEN (Assoc. M.), Niagara Falls, N.Y. (Age 45) (Claims RC 16.6 D 5.5) May 1936 to date Gen. Supt., Francis A. Canuso & Son, Gen. Contrs., Philadelphia, in charge of PWA sewage-disposal project ($2,000,000) for City of Niagara Falls; previously Contr. Engr., Niagara Falls.

DUNLOP, ARTHUR CECIL, Berkeley, Calif. (Age 46) (Claims RC 9.5 D 3.5) Oct. 1933 to date with Farm Credit Administration, Eng. Dept. (Federal Land Bank of Berkeley) as Assoc. Engr. Appraiser (Civil Service rating Engr. of hydraulics and Senior Engr. of irrigation and drainage); previously Asst. Engr.-Geologist, Div. of Water Resources, California Dept. of Public Works.

HALEY, JOSEPH PATRICK, St. Paul, Minn. (Age 46) (Claims RC 21.6 D 9.1) 1935 to date Pres., J. P. Haley Co., Inc., Contrs. & Engrs., on highway and bridge construction, grade separation, etc.; previously with Foley Bros., Inc., Darling, Minn., as Supt., Gen. Supt., Vice-Pres., in charge of operation, etc.

JAMES, ROBERT TRAFFORD (Assoc. M.), London, S.W. 1, England. (Age 38) (Claims RCA 3.0 RCM 10.5) June 1928 to date member of firm, R. T. James & Partners, Cons. Civ. Engrs., on design of foundations, steel frame and reinforced concrete work for industrial buildings, river works, and jetties.

KOFFSKY, SAMUEL (Assoc. M.), Albany, N.Y. (Age 36) (Claims RCA 4.3 RCM 5.6) Nov. 1936 to date Chf. Engr., Simmons Machine Tool Corporation, supervising design, construction and reconstruction of various metal-working machine tools, etc.; previously Asst. Supervisor of Operations, Dist. 2, WPA of New York State; Office Engr., Albany (N.Y.), County ERA, being Asst. to Chf. Engr. on all engineering work; Cons. Engr., Albany.

MACDONALD, ALEXANDER STUART, Tacoma, Wash. (Age 50) (Claims RC 22.0) 1920 to date in contracting business, until 1923 as A. S. Macdonald & Co., and since then Vice-Pres. and Gen. Supt., Strong & Macdonald, Inc., on bridges, water-front structures, industrial highway construction, and logging railroads.

MADIGAN, MICHAEL JOHN, New York City. (Age 45) (Claims RCA 7.0 RCM 15.5) 1928 to date member of firm, Madigan-Hyland, Cons. Engrs. for Long Island State Park Comm., Triborough Bridge, various Parkway Authorities, New York Central R.R. Co., and Reconstruction Finance Corporation.

MILLER, ATLEE RUSSELL, Canton, Ohio. (Age 38) (Claims RC 4.4 D 15.7) 1926 to date with Union Metal Mfg. Co. on sales engineering, Dist. Mgr. (3½ years), Elec. Engr., and at present Chf. Foundation Engr. and Chf. Elec. Engr.

MITCHELL, LESTER MORRIS (Assoc. M.), New York City. (Age 46) (Claims RC 22.5 D 8.8) March 1935 to date Chf. Engr., Merritt-Chapman & Scott Corporation, Contrs. and Engrs.; previously Vice-Pres., Merritt-Chapman & Whitney Corporation, Duluth, Minn., and Cleveland, Ohio; Chf. Engr. and Estimator, Whitney Bros. Co., Duluth Minn., and Detroit, Mich.

SNYDER, HOWARD HALSEY (Assoc. M.), New York City. (Age 48) (Claims RCA 4.2 RCM 19.0) Jan. 1920 to date member of firm, Ball & Snyder, Cons. Engrs., designing and supervising design and construction of buildings.

VANNORT, BERTRAM ORLANDO, Port Deposit, Md. (Age 38) (Claims RCA 2.3 RCM 9.2) Aug. 1938 to date in private practice, involving design and supervision of construction of rural electrification lines (3 projects); previously Constr. Supt., The Arundel Corporation, in charge of electrification construction of Pennsylvania R.R.; with Gibbs & Hill, Inc., Cons. Engrs., successively as Designer, Field Engr., and Asst. Engr.

WEIR, WILLIAM VICTOR, St. Louis, Mo. (Age 36) (Claims RC 9.2 D 9.2) Jan. 1925 to date with St. Louis County Water Co., successively as Asst. Engr., Engr. and Asst. Mgr., Chf. Engr. and Asst. Mgr., and at present Supt. and Chf. Engr.

WILLIAMSON, JAMES STANLEY, Columbia, S.C. (Age 43) (Claims RCA 5.8 RCM 13.5) Aug. 1922 to date with South Carolina Highway Dept., successively as Res. Engr., Maintenance Supt. and Supervisor, Asst. Div. Engr., Div. Engr., Asst. State Highway Engr., and at present State Highway Engr., supervising all work, including road construction and maintenance (approx. $10,000,000 annually).

WOOLLEY, RALF RUMEL, Salt Lake City, Utah. (Age 54) (Claims RCA 3.3 RCM 19.3) Oct. 1917 to date with U. S. Geological Survey, at present supervising about 14 water-power plants and transmission systems; also served as Representative for Federal Power Comm., and checked reports on several projects.

YOUNG, CHARLES HENRY, Meadville, Pa. (Age 41) (Claims RC 10.7 D 1.6) June 1924 to date with State Dept. of Health, Harrisburg, Pa., successively as Asst. Engr., Asst. Civ. Engr., and at present Dist. Engr. in charge of engineering activities in 12 counties, etc.

FOR ASSOCIATE MEMBER

ALEXANDER, RANDLE BURETTE, Ft. Worth, Tex. (Age 40) (Claims RCA 10.6 RCM 5.0) June 1922 to date with Texas State Highway Dept., successively as Asst. Engr., Asst. Res. Engr., and at present Res. Engr.

BAILEY, WILLIAM JACKSON, Chattanooga, Tenn. (Age 37) (Claims RC 3.2 D 4.7) Feb. 1934 to date with TVA as Asst. Structural Engr., Associate Civ. Engr., and at present Office Engr. on construction of Chickamauga Dam; previously with Nantahala Power & Light Co. (intermittently); Chf. Field Engr., Aluminum Co. of America.

BEGGS, JOHN JOSEPH, Jackson Heights, N.Y. (Age 33) (Claims RC 4.9 D 2.5) May 1929 to April 1930 and Jan. 1931 to date with Topographical Bureau, Borough of Queens, successively as Computer and Draftsman, Asst. to Engr. in Chf. of Report Div., and (at present) Asst. to Engr. in Chg. of Bureau; in the interim Field Party Chf., Estimator and Inspector, Highway Bureau, Borough of Queens, N.Y.

BERTINO, FRED, Brooklyn, N.Y. (Age 31) (Claims RCA 0.2 RCM 4.5) Nov. 1936 to date Engr., War Dept., New York City, at present inspecting dams and dredging operations, also hydraulic research and operating reports; previously Engr. of Constr., Dept. of Health, New York City; Engr., Dept. of Parks, Staten Island, N.Y.

BRINKMAN, GERARD JOSEPH, New York City. (Age 33) (Claims RC 4.7 D 4.0) Nov. 1936 to date Eng. Asst., New York City Tunnel Authority, at present on construction of Manhattan shaft and tunnels to Queens (Contr. 4); previously Eng. Asst., Triborough Bridge Authority; Architectural Draftsman, CWA; Eng. Asst., Topographical Draftsman and Jun. Engr., Tunnel Div., Board of Transportation.

BUHLER, FRED WILLIAM (Junior), Hollis, N.Y. (Age 32) (Claims RCA 1.5 RCM 0.0) May 1937 to date Surveyor, L. A. Boyd Arctic Expedition, American Geographical Society, New York City; previously Asst. Engr., Queens Borough, N.Y.; Jun. Engr., Port of New York Authority, New York City.

CARPENTER, SAMUEL THEODORE (Junior), Swarthmore, Pa. (Age 32) (Claims RCA 2.3 RCM 0.0) Aug. 1935 to date with Swarthmore Coll., 2 years as Instructor, and at present Asst. Prof., of Civ. Eng.; previously with Ohio State Univ. as Instructor in Civ. Eng., Supervisor of field work in surveying, Research Engr., Eng. Experiment Station, etc.

CARRIER, VIRGIL SAMPSON (Junior), Elgin, Ill. (Age 32) (Claims RCA 3.5 RCM 0.0) June 1930 to date with Illinois State Highway Dept. successively as Jun. Highway Engr., Archt.'s Supt., Highways Archt., and at present Field Supt., Highways Archt., in charge of all field work, including maintenance and construction of highway buildings.

CHAPMAN, EDWARD JOHN KNOWLES, Glasgow, Scotland. (Age 27) (Claims RC 1.8) Aug. 1938 to date Designing Engr., Sir Wm. Arrol & Co., Ltd.; previously Chf. Asst. Engr. with James Williamson, C.E., Bridgeton, Glasgow; with Sir Alexander Gibb and Partners, West-

minster, England, as Pupil, Designing Draftsman, Asst. on field inspection, and Asst. Res. Engr.

Chollar, Allan Lee, Gatesville, Tex. (Age 34) (Claims RCA 7.1 RCM 2.1) Sept. 1928 to date with Texas State Highway Dept. (except Feb. to May 1935 Engr. for Rollins & Arneson), successively as Asst. Office Engr., Asst. Engr., Project Engr., Asst. Res. Engr., and at present Res. Engr. in charge of highway construction, including major drainage structures in Coryell County.

Courter, John Wayne (Junior), Denver, Colo. (Age 32) (Claims RCA 5.1 RCM 2.3) June 1929 to date with U. S. Bureau of Public Roads, successively as Student Highway Engr., Jun. Highway Engr., Jun. Structural Engr., and (at present) Asst. Highway Bridge Engr. on grade-crossing protection devices in Colorado and Wyoming, etc.

Epps, George Lasley (Junior), Topeka, Kans. (Age 32) (Claims RCA 4.6 RCM 0.0) Jan. 1931 to date with Kansas Highway Comm., successively as Senior Bridge Draftsman, Jun. Designer, and (at present) Senior Engr., responsible for analysis design, and detail drawings for bridges and viaducts, etc.

Fortson, Eugene Palmer, Jr. (Junior), Vicksburg, Miss. (Age 32) (Claims RCA 2.1 RCM 2.0) Dec. 1932 to date with U. S. Waterways Experiment Station on hydraulic model studies, as Sub-Inspector, to Jun. Engr., and at present Asst. Engr. in responsible charge of section of Hydr. Laboratory.

Hansen, Fay Nelson, Louisville, Ky. (Age 32) (Claims RCA 7.0 RCM 0.4) May 1930 to Sept. 1933 and July 1934 to date with U. S. Geological Survey as Jun. Engr., and at present Asst. Engr., being First Asst. to Dist. Engr.; in the interim graduate student at University of Michigan Law School.

Havens, Andrew Cant (Junior), Brentwood, Pittsburgh, Pa. (Age 32) (Claims RC 4.3) Oct. 1933 to date with Koppers Co. (American Tar Products Co.), until June 1934 on Graduate Fellowship in Highway Research, and at present Highway Engr., Research Dept., Tar & Chemical Div.; previously Instructor in Civ. Eng., Univ. of Pittsburgh.

Herring, Vernon Maurice (Junior), Baltimore, Md. (Age 32) (Claims RC 4.1) Dec. 1937 to date with Maryland State Employment Service as Div. Mgr., and (at present) Chf., Placement Div.; previously with FEA of PW, successively as Engr., Engr. Examiner, and Administrative Asst. to Acting State Director.

Jewell, Robert Burnett (Junior) Flushing, N.Y. (Age 32) (Claims RC 3.6) June 1930 to Feb. 1932 and Sept. 1933 to date Jun. Engr., Port of New York Authority, acting as Inspector, Party Chf., Acting Res. Engr., and (at present) Chf. Inspector on George Washington Bridge, Lincoln Tunnel, etc.; in the interim Plant Engr., B. J. Harrison Eng. Co., and Acting Party Chf., Connecticut Highway Dept.

Leupold, Norbert Herman (Junior), Portland, Ore. (Age 32) (Claims RCA 7.4 RCM 0.0) Aug. 1934 to date with U. S. Engrs., as Prin. Draftsman, and (at present) Asst. Engr. in charge of hydraulic and hydrological studies for flood control; previously Engr. with Leupold, Volpel & Co.; Draftsman, Stevens & Koon, Cons. Engrs.

Levy, Jacob Herman (Junior), Philadelphia, Pa. (Age 33) (Claims RC 10.4 D 2.9) Sept. 1934 to date in private practice as Engr. and Contr. on various work for American Steel Eng. Co., etc.; previously Acting Supervisor on CWA project for Bureau of Bldg. Inspection, Philadelphia; Engr., Robbins Contr. Co., Philadelphia, Pa. on building construction; Engr., S. Yellin & Son, Philadelphia, Pa.

Libutti, Albert (Junior), Providence, R.I. (Age 31) (Claims RC 6.2 D 3.9) April 1931 to date with M. A. Gammino Constr. Co., successively as Asst. Supt., Cost Engr., Supt., Supt. and Engr., and at present Engr. and Estimator, estimating and designing various structures, etc.; previously Draftsman and Estimator, Rhode Island Board of Public Roads.

Liccione, Daniel Joseph (Junior), Binghamton, N.Y. (Age 32) (Claims RCA 3.0 RCM 0.0) Jan. 1937 to date Senior Draftsman Corps. of Engrs., War Dept.; previously Asst. Engr. and Engr., Navy Yard, Brooklyn, N.Y.; Draftsman, Dept. of Public Markets, New York City.

McDougall, Leslie, Phoenix, Ariz. (Age 38) (Claims RCA 5.5 RCM 2.0) 1933 to date with Arizona Highway Dept., successively as Chainman Field Office Engr., Draftsman, Transitman, Highway Designer, and (at present) Traffic Mgr., highway planning survey.

Natt, George John, New York City (Age 33) (Claims RC 2.5 D 2.2) April 1937 to date Jun. Hydr. Engr., Public Service Comm., New York State; previously with American Water-Works and Elec. Co., New York City, successively as Draftsman and Asst. in Purchasing Dept.

Palmer, Clyde Luellen, Detroit, Mich. (Age 36) (Claims RC 4.1 D 4.7) March 1936 to date Jun. Engr. of Sanitary Design, City Engr.'s Office, Detroit, Mich.; previously Secy. and Treas., Co-Op. Oil Co., Oil Well Drilling Contrs.; Civ. Draftsman, City Engr.'s Office, Detroit, Mich.

Phimister, Albert, St. George, Staten Island, N.Y. (Age 32) (Claims RCA 8.0 RCM 0.0) Jan. 1931 to date with U. S. Engrs., as Sub-Surveyman, Chf. of Survey Party in New York and Puerto Rico, and at present Surveyman, Chf. of Survey Party, New York and New Jersey rivers and harbors.

Pinney, Jabez Preston, San Francisco, Calif. (Age 59) (Claims RC 3.8 D 11.8) April 1935 to date on structural steel and reinforced concrete design in San Francisco, successively in private practice with Mark Daniels, Archt., and Leland Rosener; previously with San Francisco-Oakland Bay Bridge.

Pretious, Edward Sinclair, Vancouver, B.C., Canada. (Age 34) (Claims RCA 1.0 RCM 0.0) 1930 to 1938 Instructor, Dept. of Civ. Eng., University of British Columbia, Vancouver, Canada; previously Asst. Engr., J. Alexander Walker and Associates, Civil, Town Planning, Landscaping Engrs., and Land Surveyors.

Rose, William Allen, Flushing, N.Y. (Age 31) (Claims RCA 3.0 RCM 7.4) Sept. 1938 to date Asst. Prof. of Structural Eng., New York Univ.; previously Asst. Engr., New York Central R. R. Co.; Structural Designer, U. S. Army; Tracer, Draftsman, and Chf. Draftsman, A. Fraser Rose, Cons Engr.

Schoene, Carl William (Junior), Columbus, Ohio. (Age 32) (Claims RC 9.5) June 1928 to date with Div. of Eng., Sewer Dept., City of Columbus, as Draftsman, Res. Engr., Asst. Engr., and (at present) Senior Asst. Engr., being Field Engr. in direct charge of construction of about 39 sewer contracts ($2,225,000).

Showell, Carter Seddon, Denver, Colo. (Age 33) (Claims RC 2.3) Aug. 1936 to date Jun. Engr., U. S. Dept. of Interior, Bureau of Reclamation, Earth Laboratory, Denver (Colo.) Office; previously Service and Installationman, W. H. Bintz Co., Salt Lake City, Utah; Laborer, Joint Setter, Axeman, etc., successively with Christensen & Gardner Constr. Co., Mullins & Wheeler Constr. Co., and Utah State Road Comm.

Starr, William Lawrence (Junior), Lufkin, Tex. (Age 32) (Claims RCA 10.0 RCM 0.0) May 1932 to date with Texas State Highway Dept. as Instrumentman, Asst. Office Engr., and at present Office Engr. on plans and design; previously Constr. Foreman, Stanolind Pipe Line Co., Kansas City, Mo.; with Missouri State Highway Dept., first as Draftsman, then Instrumentman on surveys.

Stern, Charles George (Junior), Washington, D.C. (Age 29) (Claims RC 2.3) Sept. 1935 to date with Resettlement Administration (Farm Security Administration) as Asst. Project Analyst, Works Progress & Reports Div. and (at present) Office Engr., Inspection Div., being Asst. to Superv. Engr. Inspector; previously Asst. Aeronautical Map Draftsman, Airway Mapping Sec., U. S. Coast & Geodetic Survey.

Stocking, Frank McKee, Olympia, Wash. (Age 47) (Claims RCA 23.3 RCM 0.0) Oct. 1937 to date Chf. Engr. for Commr. of Public Lands, State of Washington; June 1919 to Sept. 1937 Prin. Asst. to State Field Engr. of Washington, in charge of various surveys, also supervising computing and drafting.

Taylor, Thomas Geer (Junior), Clarendon Hills, Ill. (Age 32) (Claims RC 3.3) Feb. 1933 to date with Portland Cement Association, $5^1/_2$ years as Asst. Engr., and since Sept. 1938 Associate Engr.; previously graduate student and Graduate Research Asst., Eng. Experiment Station, Univ. of Ill.

Thomson, Earl John Joseph, Kansas City, Mo. (Age 32) (Claims RCA 2.9 RCM 0.0) Aug. 1935 to date with Burns & McDonnell Eng. Co., Cons. Engrs., investigations, drafting, design, and reports in various cities and states.

Turnbull, John MacNeil, Victoria, Australia. (Age 41) (Claims RC 10.7 D 3.0) March 1922 to date Asst. Engr., Hume Pipe Co. (Aust.), Ltd., having charge of Testing and Research Dept.

Ure, James Edwin (Junior), Mt. Kisco, N.Y. (Age 32) (Claims RCA 5.4 RCM 0.0) Aug. 1938 to date Eng. Inspector, Grade 4, Board of Water Supply of New York on Delaware Aqueduct; previously Jun. Engr., Port of New York Authority; Field Engr. with DiMarco & Reimann.

Wentworth, Winslow Clarence (Junior), Greenfield, Mass. (Age 32) (Claims RCA 7.1 RCM 0.0) June 1929 to date with Turners Falls Power & Elec. Co. successively as Chf. of Party, Res. Engr., and since Feb. 1931 Engr., Hydr. Eng. Dept., being Res. Engr. in charge of construction.

Wheeler, David Houston, San Andreas, Calif. (Age 32) (Claims RCA 5.0 RCM 0.0) 1933 to date with Calaveras Cement Co. as Eng. Asst. and Plant Engr., at present on miscellaneous industrial plant engineering, including testing equipment and operation, etc.

Young, Lewis Alaric (Junior), Cambridge, Mass. (Age 32) (Claims RCA 3.5 RCM 1.8) Oct. 1936 to date Asst. Engr., Kansas State Board of Health, Lawrence, Kans.; since Sept. 1938 (on leave of absence) Graduate Student in San. Eng., Harvard Univ.; previously Engr. with Chas. A. Haskins, Cons. Engr., Kansas City, Mo.; San Engr., Wilson Eng. Co., Salina, Kans.; Asst. to Chf. Draftsman and Topographer, Venezuela Gulf Oil Co., Maracaibo, Venezuela.

FOR JUNIOR

Hammes, Kenneth William, Glendale, Calif. (Age 26) 1938 B.S.C.E., Univ. of Ariz.; Sept. 1938 to date Recorder, U. S. Geological Survey, Hydr. Dept., Water Resources Branch.

Hellmann, Francis Richard, Jr., Catlettsburg, Ky. (Age 21) 1938 C.E., Univ. of Cincinnati.

Lockett, John Bolling, Kirkwood, Mo. (Age 29) (Claims RCA 0.7 RCM 0.0) Oct. 1935 to date Jun. Civ. Engr., Upper Mississippi Valley Div., Corps of Engrs., U. S. Army, St. Louis, Mo., and (at present) 2d Lieut., 459th Engrs. (Topographical) Battalion, Regular Army, Inactive (Organized Reserves); previously Jun. Highway Engr., Illinois State Highway Dept., Dixon, Ill.

Luna, William August, New York City. (Age 31) Feb. 1938 to date Field Asst., World's Fair Corporation; previously Chf. of Party with Pres., Borough of Manhattan, N.Y.; Efficiency Expert, Rome Mattress Co., Long Island City, N.Y.

Murphy, Joseph Aloysius, Brooklyn, N.Y. (Age 23) 1938 B.C.E., Coll. of City of N.Y.; July 1936 to June 1938 and Oct. 1938 to date Recorder, U. S. Geological Survey, Dept. of Interior, and assisting Hydraulogist, Chartist and Draftsman.

Nichols, Don Lee, Mandan, N.Dak. (Age 28) (Claims D 1.3) Summer 1937 and Jan. 1938 to date Engr. and Draftsman, North Dakota Water Conservation Comm., also since July 1938 Acting City Engr., City of Mandan; previously Highway Draftsman, North Dakota State Dept. of Highways; Asst. County Surveyor, Morton County.

Parkinson, Clyde Philip, Albany, N.Y. (Age 28) (Claims RC 2.6 D 0.1) Aug. 1936 to date Jun. Hydr. Engr., U. S. Geological Survey; previously Asst. Project Engr., Indiana State Highway Comm.; Engr., AAA; Camp Engr., U. S. ECW Camps (Forest Service).

Quattlebaum, Alexander McQueen, Clemson, S.C. (Age 25) (Claims RC 2.5 D 0.3) Sept. 1937 to date Asst. Prof., Civ. Eng. Dept., Clemson (S.C.) Agricultural & Mechanical Coll.; summer 1938 Engr., D. T. Duncan Eng. Co., Ninety-Six, S.C.; previously Eng. Aide, TVA, Knoxville, Tenn.; Laboratory Asst., South Carolina Materials Testing Laboratory, Columbia, S.C.

Raffin, Bennett Lyon, Stanford University, Calif. (Age 21) 1938 A.B. in Eng., and at present graduate student, Leland Stanford, Jr. Univ.

Reichmann, Paul Adolph, New York City, (Age 21) 1938 B.C.E., Coll. of City of N.Y.

Reynolds, Don Potter, Toledo, Ohio. (Age 23) 1938 B.S.E. in C.E., and M.S. in Eng., Univ. of Mich.; July 1938 to date Jun. Eng. Aide, City of Toledo, being Acting Asst. to Director of Public Service.

Robbins, Harold Moyer, San Francisco, Calif. (Age 23) Feb. 1938 to date Structural Eng. Office Aid, State of California Comm. for Golden Gate International Exposition, acting as Structural Draftsman and Clerk.

Schmitt, Charles Norman, Cincinnati, Ohio. (Age 26) (Claims RC 2.0 D 2.0) April 1934 to date (until Feb. 1935, while student) with Procter & Gamble Co.

Scoralick, Henry Walter, Pelham Manor, N.Y. (Age 27) 1938 B.C.E., N. Y. Univ.; at present San. Inspector (Food), Westchester County Dept. of Health, White Plains, N.Y.

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